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British Foundrymen's Association.

Fourth Annual Convention at Sheffield.

The 4th annual Convention of the British Foundrymen's Association was held in the Department of Applied Science of the University of Sheffield on Tuesday and Wednesday, August 6 and 7. The attendance was considerably larger than in previous years, and the gathering was from a social point of view entirely successful. By the sympathetic co-operation of Professor Arnold, of the Metallurgical Department of the University, an excellent room had been placed at the disposal of the delegates, sufficiently ample to find seating accommodation for everyone, yet small enough to make the task of the speakers easy and pleasant. An interesting feature of the opening proceedings was a visit of the Lord Mayor of Sheffield, wearing the chain of office, and accompanied by the Master Cutler, both of whom gave addresses of welcome. The extremely able address of the Lord Mayor evoked the greatest enthusiasm. The afternoons of the first two days were devoted to visits to important industrial establishments in the neighbourhood, and on the third day the party drove to Chatsworth House, Haddon Hall, and Bakewell. A social function specially appreciated was the Smoking Concert arranged by Mr. F. Bagnall, at the King's Head Hotel, and at which there was a very large attendance.

The meetings were presided over by the President, Mr. Herbert Pilkington, M.I.C.E., the Vice-President, Mr. F. J. Cook, occupying a seat at his right. Other members were present as follows:—Messrs. R. Buchanan (Walsall), Past President—British Foundrymen's Association), C. Heggie (Birmingham Secretary British Foundrymen's Association, F. W. Finch (Gloucester) (General Secretary), W. W. Sherburn (Warrington), E. C. Blackmore (Cardiff), C. Jones (Cardiff), W. Hughes (Bishop's Stortford), J. M. Tyte (Erith), B. Soyres (Bristol), Arthur Bowman (Burnham), C. C. Booth (Burnham), M. H. Curnow (Penryn), F. Andrew (Oldham), W. Jones (Blaenavon), R. W. Kemlo (Sheffield), E. Kam (Sheffield), W. Broughton (Redcar), W. Gamming (Dunblane), G. W. Sloper (West Hartlepool), J. Smith (South Shields), W. Sword (Dudley), J. Shaw (Dudley), H. Grandidge (Bury), R. Mather (Middlesbrough), D. J. Niven (Sheffield), G. F. Parramore (Sheffield), W. Sykes (Sheffield), J. D. Sloan (Leeds), F. Howe (Chitagong, India), W. Wright (Horwich), G. Buchanan (Wrexham), H. F. Chope (Sheffield), W. H. Bagnall (Sheffield), W. Bagnall (Sheffield), J. E. Hallbut (Chesterfield), G. Hall (Chesterfield), W. H. Mainwaring (Chesterfield), J. Peach (Chesterfield), T. W. Baugh (Birmingham), T. Macfarlane (Horsehay), R. Mason (Birmingham), A. Sismith (Leeds), P. Longmuir (Sheffield), D. Lowe (Manchester), I. L. Magson (Littleborough), J. Chadwick (Bolton), R. F. Walker (Uttoxeter), J. Ellis (Southampton), H. Jewson (Dereham), G. N. Fletcher (King's Lynn), H. P. Mason

(Oldham), W. A. Young (London), H. Pemberton (Derby), D. Dalrymple (West Bromwich), W. F. Bagnall (Sheffield), G. Uddey (Sheffield), G. M. Mather (Ashford), B. Gannell (Newark), J. Bullock (Smethwick), J. B. Tattersall (Birmingham), S. McConnell (Leicester), H. Winterton (Birmingham), J. H. Jameson (Manchester), E. Oakes (Manchester), J. Poole (Birmingham), J. H. Smethurst (Warrington), C. Haslam (Chesterfield), G. Phillips (Chesterfield), E. Albert (Chesterfield), R. W. Kenyon (Manchester).

The PRESIDENT, who had a very hearty reception, said :—

"In opening this meeting I do not think it necessary to make many remarks, as I am afraid I shall have a lot of talking to do afterwards. I am very pleased the Convention has come to Sheffield, in my own immediate neighbourhood. We will try and do our best to properly entertain you, and show you what we have to show. We have not been quite so successful about the papers as we might have been. I do not know the reason why; but there is considerable shyness in giving papers. But I think after all, the programme will meet with your approval. This is a business meeting, simply open to members, and after that, we have to receive a welcome from the Lord Mayor, and the Master Cutler. First of all, I should like Mr. Finch, if he will be good enough, to read the Secretary's report for the past year."

MR. F. W. FINCH, who was greeted with cheers, read the report as follows :—

"Mr. President, Vice-President, and fellow-members,—In presenting my fourth annual report, it is a pleasure to inform you that since our last Convention in 1906, our Association has made grand progress, both financially, and in respect of a great increase in membership. At the last Convention we had enrolled upon our books 169 ordinary members, and five life honorary members. At the present time we have 245 paying members, and, including the five life honorary members, this makes a grand total of 250 members. Since the last Convention we have enrolled 97 new members, comprised of 52 honorary members at a guinea each, and 82 ordinary members contributing 7s. 6d. each. Since January of this year we have enrolled seven honorary and 62 ordinary members."

"I am sorry to say that we have lost two members by death, one of whom was known to the majority of our members. This was Mr. John Butler, of Messrs. Evans & Company, Manchester. He attended each of the Conventions from the commencement of the Association. The other member was Mr. W. H. Richards, of Darlaston."

"During the year eight of our members have sent in their resignations, and eight have dropped out by reason of their not continuing their subscription. I am pleased to say that up to date, 115 of our old members have sent in this year's subscription. It is also a pleasure to report that our financial position is in a satisfactory state. At the end of the year 1906 we had a balance of £22 15s. 3½d. The income from January to July this year was £73 10s. 9d., and the expenditure £25 2s. 8d. leaving a total balance of £71 3s. 4½d. at the present time for future requirements. I have to apologise to the members for the rather late arrival into their hands of the "Proceedings" of the Convention held at Middlesbrough in 1906. But I can assure them that it was through no fault of my own, and that as soon as it was possible, I sent one to every member, and one also to every new member as soon as he joined, and as long as the copies lasted."

"The branches have been doing most excellent educational work during the past session, and also very good work in getting new members to the Parent Association. Your President, Mr. Herbert Pilkington, has read papers before the members of the Birmingham and Manchester branches. Your Vice-President, Mr. F. J. Cook, has read papers before the members of the Birmingham and Cardiff branches. Mr. Percy Longmuir has also read papers before the members of the Birmingham and Manchester branches, and the Council take this opportunity of thanking both members and non-members who have kindly come forward and read papers at our branch meetings. Among these, special mention should be made of our honorary life member, Professor Turner, whom we all thank for his kindly interest in our Association."

"The Council has been called together four times since the last Convention, the majority of its members attending each time. At the annual meeting held in March of this year, the following places were nominated for the holding of this Convention, namely Sheffield, Newcastle, and Halifax, and the dates fixed were August 6, 7, and 8. I sent out circulars and voting postcards to every member of the Association; 178 cards were returned,

with the result that Sheffield received 99 votes, Newcastle 49, and Halifax 30, which proved that a good majority of the members took the trouble to return their cards in this democratic manner. But the time is not far distant when we shall have to arrange other dates than Bank Holiday. During the year, I have sent out a thousand circulars to employers requesting them to become honorary members of the Association, and assist the Council in the good work of educating the foundrymen in the scientific and practical part of foundry working. The result was that eight joined last year, and seven this year. One of these new members is Stanley G. Flagg, Esq. Junior, the recently-elected President of the American Foundrymen's Association, who I believe is present now, or will be present during the Convention meetings, he having returned me a postcard to that effect. We have also two members present, out of three whom we have in India. If not already present they will be present during the meetings."

"The arrangements for the present meeting have been in the hands of our local members, with our President as Chairman, and Mr. Percy Longmuir as Secretary, Mr. W. F. Bagnall has kindly looked after the arrangements for the Smoking Concert, which will take place on Wednesday evening, as stated in the programme. Preliminary notices of the Convention with voting postcards were sent to each member. Some members returned their cards saying that they will be present at the Convention, but a large number were not certain of being able to attend; 150 cards have been returned, and 77 promised attendance. The official programme was also sent to every member last week."

"I am sorry to say that several of our old members have not yet sent in this year's subscription, but my hope is that everyone will retain his membership and so help to strengthen our Association."

"I take this opportunity of thanking our President, the Vice-President, and members of the Council for the assistance they have given me during the year. Two members have resigned their position on the Council, namely Messrs. J. G. Stewart (Urmston), and G. P. Varley (St. Helens). These resignations are owing to pressure of business, and your Council by electing two Vice-Presidents and the branch Presidents as *ex officio* members, will cause vacancies for five new members on the Council. At the last Council meeting I was requested to write to the following gentlemen asking them to allow their names to be submitted to this meeting, namely, Messrs. R. W. Kenyon (Accrington), S. A. Gimson (Leicester), James Oswald, Junr. (London), and P. Munnoch (Middlesbrough), all of whom have consented to allow themselves to be nominated as members of the Council."

"In conclusion, as your Secretary, I can assure you that I have done the best in my power to further the interests of the Association. The work connected with it has been very heavy indeed; in fact, it is getting heavier every year. Every new member has been written to, and the other correspondence has also been very heavy. Nearly the whole of my spare time during the year has been given to the interests of the Association. As usual, I have done my very best to land everyone who has written asking for particulars. I have not been able to land all of them; but I take this opportunity of thanking those who have assisted me in getting new members, and also those who so kindly sent me in response to my application lists of shops and names of foremen and managers in their districts, thus enabling me to increase the membership considerably. I trust those who have not sent in their lists will do so, and I again ask every member of this Association to do his best in trying to get new members during the coming year."

"Gentlemen, I trust I have given you all satisfaction as your Secretary."

The PRESIDENT: Gentlemen, I beg to move that the Secretary's report be received and adopted. I am sure everyone here feels that Mr Finch has done his best during the past year.

MR. F. J. COOK: I have great pleasure in seconding that, and can only endorse what the President has said, and what everyone closely connected with the Association knows that Mr. Finch has done very well indeed, and has done his best.

The report was unanimously adopted.

The Secretary read the minutes of the Convention at Middlesbrough, in August 1906, which were approved.

MR. H. WINTERTON (Birmingham): I have pleasure in moving that the best thanks of the Association be given to the President, Vice-President, and officers of this Association for their services during the past year. I am quite sure, that in our President we have the right man. He has done a wonderful lot of work during the year, and as far as Mr. Cook is con-

cerned those from Birmingham will bear witness to the fact that he is a hard worker in the interests of the Association in that city. (Hear, hear.) As the meetings of the Association are held primarily in Birmingham I have an excellent opportunity of knowing that the members are very regular in their attendance, and the amount of work they get through can only be gauged by the fact that the Association has made such strides during the past twelve months. No small share of this success is due, particularly in regard to the new members of the Association of whom so many were added during the year, to the labours of Mr. Finch. We are all agreed that his work as Secretary of this Association up to the present time, has been the best he could do. He has worked hard and thoroughly, and I feel that every member of the Association owes him a deep debt of gratitude for the manner in which he has helped to build it up to its present position. The Association is growing rapidly, and it is becoming a matter of considerable difficulty to give to it the amount of time it requires. Mr. Finch has done very well in the past, and we are all very thankful to him, and we wish him every success in the future in whatever he may undertake. So far as this Association is concerned, we must tender him our heartiest thanks, together with the rest of the officers.

Mr. E. C. Blackmore (Cardiff) : I have great pleasure in seconding the vote of thanks so ably proposed. It requires no words from me to secure that this resolution shall be carried unanimously and with acclamation. In matters of this kind the success or otherwise of the Association must depend upon our officers, and that success is shown by the large number I see around me who have travelled from far and near to this Convention to-day. I have great pleasure in seconding the vote of thanks.

The resolution was carried with much enthusiasm.

The Chairman : The next business is the election of officers for the ensuing year, and the first election is that of President.

Mr. F. J. Cook (Birmingham) : I have very great pleasure in submitting the name of Mr. Pilkington to be President of the Association for the ensuing year. (Applause.) The name is well-known to you, and also the work that the President has done during the past year. That work has been sufficient to warrant his being accepted as President for another year. That work, I am sure, has been very helpful in building up our Association. Such an Association, especially in its early stages, is very dependent for its success upon the manner in which the officers do their work. It requires no words of mine to laud the work the President has done, and I don't propose to take up your time by any further remarks. I have great pleasure in proposing that Mr. Pilkington be re-elected President for the coming year.

Mr. R. Buchanan (Walsall) : Mr. Cook, and gentlemen,—I have great pleasure in seconding the proposal that Mr. Pilkington be President during the ensuing year. As Mr. Cook has said, there are no words required to extol the work he has done. We know what a fit and able man he is, and how wide is his experience, and how well able he is to put his views into good form. I think you can make no better choice than by re-electing him President for the next year. I have much pleasure in seconding his re-election.

Mr. Cook put the resolution, which was unanimously carried with acclamation.

The President : I thank you very much for re-electing me President. As you know, it was thought that thus early in the history of the Association it might be wise for the President to occupy the position for two years. That is to say, it was simply an opinion. There is no rule or reason why the President should be elected for a second year. But it may be that some members do not quite understand this point. However that may be, I am sure you will know that I will do everything in my power to promote the interests of this Association. I joined with that specific object, and I should be sorry indeed if I did not help to do some little towards increasing the success it has already attained. The next item is the election of Vice-President. The Council determined to suggest to this meeting that we should have two Vice-Presidents in future instead of one. It is not my duty to propose the Vice-Presidents, that being left to their nominators at the Council meeting. Whoever's duty it is to propose Mr. Cook will they kindly do so. However, I have great pleasure in proposing Mr. Cook. I think he will make an excellent President when the time comes. (Hear, hear.) I propose him as the first Vice-President. I know no one who has the interests of the Association better at heart than he has, and I have pleasure in putting his name to the meeting.

MR. PERCY LONGMUIR (Sheffield): I have much pleasure in seconding that.

The resolution was unanimously carried.

MR. R. MASON (Birmingham): Mr. Chairman and gentlemen, I have got one of the pleasantest duties to perform, and I generally fall in for some of the nice work. I have to propose the election of the second Vice-President, and I have much pleasure in proposing Mr. Percy Longmuir. Everyone of us knows Mr. Longmuir, and if we don't know him personally, we know him for some of the work he has done. We have heard his papers, and we know the reliability of any article written by Longmuir. You know how anxiously we look forward to anything that is to be done by him. It is our duty to raise him to the highest point we can by raising him to the position of Vice-President, with the idea that in due time he will be President, and will then add as much honour to that position as he now adds to the position of simple member. He has attended all the Conventions, and he attends all the Council meetings, coming from Sheffield to Birmingham. We never hold a meeting without Mr. Longmuir being there. His interest is second to none, and I have much pleasure in proposing him as the Vice-President.

MR. W. H. SHERBURN (Warrington): Our friends must not think because there is so little speaking it is because there is any feeling of hesitation. But there was an understanding that those who proposed and seconded at the Council meeting should do so again. That seems to have been rather forgotten. I am not sure I am one who ought to fill the place now, but I don't want it to be thought that there is any real hesitation, and I have much pleasure in seconding that motion and supporting all that Mr. Mason has said about Mr. Longmuir. It is almost unnecessary, because we all know him so well. (Applause.)

The resolution was heartily carried.

The CHAIRMAN: The next business is the election of the Council. You have heard from Mr. Finch's report what the Council suggested is, that the names be filled in with the addition of those he read to you and those names I propose. There is still one vacancy in addition to those filled by those we propose electing. I suggest that we should add the name of Mr. Finch. (Applause.) And I propose we take the whole of the names *en bloc*.

MR. FINCH (Gloucester): I cannot take any position on the Council.

The PRESIDENT: If Mr. Finch does not care to join the Council I suggest that we leave that point open, and I will put the rest of the proposed Council *en bloc* to you. Please vote on those four names in the Secretary's report.

The resolution was carried.

The PRESIDENT: The next business is the election of Secretary, and I call upon Mr. Jones, the President of the Cardiff section, to propose him.

MR. JONES (Cardiff): Mr. President and fellow-members,—I have pleasure in proposing as Secretary of this Association Mr. J. E. Hallbut, of Chesterfield. In doing so I have every confidence that Mr. Hallbut will do the secretarial work of this Association in a very efficient manner. I do this with the greatest amount of appreciation for the work of our old and esteemed Secretary, but I have come to the conclusion by attending the Council meeting from time to time that the work has been too much for Mr. Finch to carry out efficiently, and the sole object of proposing a successor is to relieve him of what has become too heavy. The Association is growing rapidly, and we really want a man who can give the requisite time to it. It is unjust for us to expect that he can give us the whole of his time. I have great pleasure in proposing the election of J. E. Hallbut.

MR. S. MCCONNELL (Leicester): I endorse everything that has been said about the work of the Secretary. It is with great regret that we have come to the conclusion that the work is too heavy for Mr. Finch. If we carry our minds back to Middlesbrough we shall remember that Mr. Finch then said the work was getting beyond him, and I believe he offered then to resign. But we pressed him to once more accept office. It is in the interests of the late Secretary that I have pleasure in seconding the name of Mr. Hallbut.

MR. J. SMITH (South Shields) nominated Mr. Finch for re-election as Secretary, but that gentleman declined to accept nomination, remarking that what he had done had been done with a labour of love, and that he still had the best interests of the Association at heart as much as any member. He hoped that the new Secretary would do even better than he had done himself.

At this stage the business proceedings were interrupted on the intimation that the Lord Mayor and Master Cutler had arrived. His lordship, who was wearing his chain of office, and the Master Cutler, also decorated with the medallion of the Cutler's Company, were very warmly received, the entire company rising as they entered.

The LORD MAYOR, who was received with applause, said:—

Mr. President,—My first duty is a very pleasant one, and it is to bid your Association a very hearty welcome to the city of Sheffield. I believe this is the first time you have met here, and we are very glad indeed to welcome you. We hope the result of your proceedings will be to make this one of the most successful of the Conferences you have held. Although Sheffield is not the centre, and cannot fairly be considered as the centre of the ironfounding industry, we are, as everyone must know, very closely and very intimately connected with everything that affects the iron industry in all its branches. In regard to certain particular branches, such as heavy casting for anvils and anvil blocks, and matters of that sort, I suppose there is no place in the world where castings of a larger character are sent out. Apart from that, we have not any particularly large concern engaged exclusively in ironfounding. Of course, whilst this may be so, so far as Sheffield itself is concerned, in the immediate neighbourhood there are concerns of the greatest importance. At Sheepbridge, where your President is so largely interested, at Staveley, and at Stanton, ironfounding is carried on in its greatest magnitude. Speaking of those three places leads one more particularly to think of ironfounding in connection with the great pipe industry. It fell to my lot only a few days ago to see some of the original apparatus connected with the conveyance of water for the supply of large centres of population. I saw taken up and stored carefully in the museum some old wooden pipes which used to be the only means of conveying water underground in large quantities. It was taken through wooden blocks of elm, which were bored out to a diameter of 3 in. or 4 in., and that up to comparatively recent times, as late even as the commencement of last century, formed the only means by which water could be conveyed underground. Now we see the enormous development made so that we think nothing of conveying water in iron pipes, 40 in., 42 in., and as high as 45 in. in diameter. Of course, you would have a large claim upon the interests of the city of Sheffield in association with that of other large towns, if you were concerned in nothing else than the production of pipes of this character. We all recognise that we are under a great debt of obligation to the ironfounding industry in this connection. Personally, I have some interest in the matter, inasmuch as in a public capacity I have been concerned in placing large orders for iron pipes in connection with our recent undertaking at Sheffield in the extension of our water works at Langsett Valley. We have placed orders for iron pipes to the extent of 19,000 tons. In connection with the Derwent Valley scheme, of which Board I have the honour to be a member, and which is supplying water to Sheffield, Derby, Nottingham, and Leicester, we have placed orders for iron pipes of large diameter to the enormous extent of 154,000 tons. (Applause.) So you will easily see that I personally am greatly interested in this important manufacture.

In Sheffield we have done, and are doing, our share towards developing the industry in which you are so much concerned and interested. In this particular building, the Applied Art section of our University, particular and great care and attention is given to the development after examination and study of ironfounding and of steel-founding in all their departments. We know perfectly well how important it has become that these questions in connection with the ironfounding industry should be studied in the scientific manner. Up to comparatively recent times, it was the usual experience in connection with ironfounding, as it certainly was in connection with steel-making, that practically all the processes were carried out by rule of thumb. Now we know perfectly well that entirely different methods have been adopted, and the scientific method has been produced with the greatest possible advantage to the industry itself. Now, if this is true of iron, it is infinitely more so of steel-founding, which is becoming a very important section of the operation in which your Society takes an interest. Of course, in connection with steel-founding one cannot in Sheffield speak of that rapidly-extending industry without some reference to the brilliant work which has been done by our townsman, Mr. R. A. Hadfield. I suppose Mr. Hadfield has done more for the steel-founding industry that perhaps was ever done by any single individual in connection with that large industry.

Now, in connection with the distribution of water, and more so, perhaps, with the extension of the tramway systems of our large cities, enormous demands have been made upon the products in which you are concerned. We know that in our large centres of population it would be practically impossible to carry on tramway undertakings in anything like a satisfactory manner, if it were not for the

splendid output which we receive from the steel foundry in connection with the points, crossings, and other parts of the undertakings.

One most interesting feature, both in connection with the development of water supply and tramway undertaking, is that, immediately the demand has arisen for great advances, the difficulties which before hand were thought to be insuperable, have been overcome, and the supply has been produced to meet the demand. It shows us, in regard to the two matters of which I have spoken, how large a field there is open for your industry.

I don't suppose any of you who gives consideration to the subject at all has come to the conclusion that you have reached the ultimate limits of what is possible in connection with the iron and steel industry. I am quite certain that those who take a wide view of the subject must have concluded that there is still an immense future before you. I think everyone must be satisfied that the hope of the future lies in the development of scientific methods. (Applause.) Scientific methods have already led to the use of ores, previously thought to be altogether unsuitable and impracticable for a particular purpose, and they have enabled the very satisfactory result, of which I have spoken, to be attained. I take it that in connection with the scientific methods, the object is to ascertain what is capable of being eliminated, what of a deleterious character there is in the ores which should be got rid of, and what can be added to make the use of these ores satisfactory. So far as my observation has gone in this direction, it has been the infinitely little which has received attention, and the infinitely little which has, either in addition or subtraction, produced such a satisfactory result; how it reminds one of the saying of the Apostle so long ago, "that God has selected the weak thing to confound the things that are mighty." All science shows how completely true that is. Then we find that in every branch of science the result is precisely the same. If we come to medicine or surgery, cancer research, malarias, sleeping sickness, the study of radium, the Röntgen rays, astronomy, solar photography, in any and all of these things it is the same infinitely little which is shown to have such enormous importance and such enormous results upon the various facts under consideration. In no subject is this more true than in this important industry of iron-founding, and we must all have come to the conclusion that it is along the line of the application of scientific rules, the great success of the future will be attained; it will enable you to extend and develop the important results you have attained hitherto. We are glad to see you in Sheffield, and we are glad to find that an Association has been formed for the development of this important industry, and we feel sure that great as has been the progress already made on the scientific side, and especially in the direction of the steel-founding industry, there is still an enormous future open to you. (Applause.)

THE MASTER CUTLER: Mr. President, my Lord Mayor, and gentlemen,—It gives me very great pleasure to join the Lord Mayor in according you all a very hearty welcome to our city of Sheffield. The Lord Mayor has given you a welcome from the civic point of view, and I can claim, perhaps, to give you a welcome more from the commercial point of view. Although you may have thought otherwise, the Lord Mayor has no connection whatever with steel or ironfounding, and perhaps when I have done you will think that I ought to be a lawyer, and he ought to be a steel manufacturer. (Laughter.) We are, I am sure, very much flattered by your selecting Sheffield as a place to come to for your meeting. We are beginning to look upon Sheffield quite as a fashionable health resort, and as a place for summer gatherings. (Laughter.) Judging by the number of societies of one sort or another which visit us year after year, we are quite justified in looking upon our town and district as a place which is very attractive for some reason or other. I suppose you have come for a change of air, or a change of smoke. (Laughter.) Sheffield has not often been described as a jewel set in very nice surroundings. We are very pleased, indeed, to see you, and I, as representing an ancient company some three hundred years old, assure you that it gives me great pleasure, on behalf of the commercial community, to accord you a very hearty welcome.

The Lord Mayor made reference to the Institution in this building, and I should like to say with regard to it that it has been of immense benefit to this city. We have men connected with our own works who are now occupying important positions which they never would have occupied but for the technical knowledge and instruction they were enabled to receive at this technical school in their own city.

(Applause.) We should have had to seek far and wide to find men to fill the posts which they now occupy. I understand you have further business, and I don't intend to occupy more of your time. Again, I say, it gives me very great pleasure to give you a hearty welcome, and I hope that what you see and what you do here will be of great use and assistance in future. (Applause.)

The PRESIDENT: I am sure I am voicing the ideas of every member of this Association in thanking the Lord Mayor for coming here to welcome us to the city of Sheffield. As I shall say presently, there is no more appropriate place that we could possibly visit. We admire Sheffield people for their great and strenuous work and education, and particularly for their great ideas with regard to technical education. As a city, Sheffield is a place which any citizen who has any idea of municipal work must always admire. We are glad to come here not only to see the city, and not only to see the great works which you particularly, Mr. Master Cutler, represent, but we have come to see this Technical Institution, which is not only a technical and physical laboratory, but practically a workshop. I am not inclined to say that Sheffield is a very black place, although I believe the blackest part is called Brightside, whereas another part is called Grimethorpe. Sheffield is no mean city, and if it is black in some parts it is surrounded by the most beautiful country, as we shall probably see to-morrow, not only in Yorkshire, but in Derbyshire also. I am sure members of the Association cannot help but admire the research of the Lord Mayor, who has no interest in our particular industry, except as Lord Mayor of the city. He has shown a deep knowledge with regard to the various industries connected with the city, and he has displayed especial interest in welcoming us here with the Master Cutler, who represents the most ancient and honourable Company, which itself, as the Cutlers' Company of Sheffield, stands for the staple trade of this city. We take his visit, as well as that of the Lord Mayor, as a special honour, and we value their kindly welcome.

I propose that a vote of thanks be given both to the Lord Mayor and Master Cutler, for coming here and spending so much of their valuable time in welcoming us.

The vote was carried enthusiasm, the company once more rising.

The LORD MAYOR: So far as I am concerned, nothing has given me greater pleasure during my year of office than to meet you, and to recognise your aims and objects, which are eminently practical. We cannot claim to be a very beautiful city, but we do claim to be practical, and owing to the foresight and intelligence of some of our foremost citizens, we, a good many years ago, had this important section of our University established. It has already fully justified, as you hear from the Master Cutler, the expense and the trouble which was taken in its establishment, and so far as we in the City Council are concerned, there is nothing lies nearer our hearts than the important question of education. We recognise that those who live by the rule of thumb are destined to extinction. Now that the reign, the scientific reign of applied thought, has come upon us, if we are to hold our own in the world, we must take the advantages given to us in that direction. It is from this aspect of the case, more particularly, that we realise the importance of your Association, and I am very glad indeed to be here to have an opportunity of seeing you face to face as I do this morning. I hope, indeed, that your meetings in Sheffield will be very successful. (Applause.)

The MASTER CUTLER: I thank you very much for this vote of thanks, and I hope to see something more of you to-morrow afternoon.

The PRESIDENT: The Lord Mayor has other engagements, and he desires us to kindly excuse him now withdrawing.

The visitors then withdrew.

On resuming business the election of Mr. J. E. Hallbut was carried unanimously.

MR. HALLBUT: I thank you for the honour you have conferred upon me in appointing me Secretary. I can assure you it will be my pleasure to further the interests of the Association. I can see plenty of hard work in front of me, but I am not afraid of it. I thank you! (Applause.)

The President then proceeded to deliver his address.

Presidential Address.

Gentlemen,—In welcoming the Association to Sheffield I must first of all express my appreciation of the honour done to me by electing me your President for a second year, and that on the occasion of the visit of the Association to my district. The Association, whose prosperity we all have at heart, has continued to increase in both membership and influence, until we now number 250 members, and it is clear that this figure will soon double itself. It has been stated by the President of the

American Foundrymen's Association, that the progress of the foundry trade in America has dated from the time of the formation of their Association, and is due to the educational influence which they have exercised amongst foundrymen in all classes of work there. I take it that it is also our ambition to become in like manner, the most powerful educational influence amongst the foundrymen of this country; it is clear to everyone, at any rate, that we have laid a most solid foundation upon which to build the superstructure I have indicated. I have visited the Branch Associations at Birmingham and Manchester, but, unfortunately, was unable to do so at Cardiff, and I am exceedingly pleased to say that the whole of the three Branch Associations are exhibiting remarkable vitality and prosperity. I am hoping that this meeting will be the means of the formation of a local branch Association in this city. I have read a paper before the Birmingham and Manchester Branches on the subject of "Foundry Pig-iron Specifications," and I found no lack of lively and healthy criticism existing on this subject. I am distributing copies of this paper, but as it has already been discussed at branches, I simply propose to include it in these proceedings.

As an educational Association, as well as an Association of Foundrymen, Sheffield is a very appropriate city for us to visit. It is a splended and strenuous example of a more or less complete system of education, commencing in the elementary schools, and, by a practically complete educational ladder, attaining to the University. I know that the object which animated the founders of that University was to provide as broad, general, and thorough an education as that of any of the older Universities, but they have by no means neglected to provide facilities for the instruction and training of those engaged in the staple trades of this district, and in the scientific principles underlying their work. Indeed, I have no hesitation in saying that the metallurgical laboratory and workshop of the Sheffield University is one of the finest of its kind in the world. This metallurgical laboratory will be of special interest to the members, as will also the demonstration of pyrometry in these buildings.

Although the average man dislikes the advice, or even the example of the schoolmaster, it may not be out of place to remind the foundrymen belonging to this Association, as this University does, that there are other aspects of education than mere metallurgical work. I should like to see the members deal with subjects in their paper, not only metallurgically, but from every aspect of the foundrymen's art.

Sheffield is the home of the steel trade, and what is more directly interesting to us as foundrymen, the home of steel castings, and the members will be afforded an opportunity of seeing some of those magnificent works of which Sheffield is so justly proud. In this city steel castings of every type are made. Crucible, Siemens, and Bessemer castings, and there is no city in this country, or any other, so far as I know, where this industry is so large and so deeply rooted. Over the county border, in Derbyshire, quite near by, they will have an opportunity of seeing, amongst other things, the manufacture of cast iron pipes, which in that county has become probably more highly specialised than in any other part of the country, owing to the gradual evolution of special tackle, special handling plant, and the organised classification of the work. In addition, they will be able to see pipe foundries, general foundries, and engineering shops wholly driven by power derived from blast furnace gases.

I notice that many of the members of our Birmingham Branch, since a speech I made at another Institution in their district, have described me as a pessimist with regard to the iron and steel industry of this country, a criticism with which I have some quarrel, inasmuch as the charge is a somewhat mistaken one. In particular, I am not a pessimist with regard to our foundry trade, neither are any of us pessimists on this point in the Sheffield district. I believe the foundry trade of this country, both iron, malleable iron, and steel founding, has a great future before it. This country is a great engineering country, and what with its developments in mechanical engineering, constructional work, enginebuilding, and shipbuilding, I can only see a large and increasing prosperity in foundry work before it. What I am pessimistic about, if the spirit of criticism is pessimism, which I take leave to doubt, is the antiquated methods and the antiquated spirit with which we for the most part deal with the manufacture of castings of all sorts. I regard these methods with just the same spirit of criticism as at Dudley I regarded our antiquated and conservative fiscal arrangements, with regard to which, however, I will say nothing further, as the subject appears to be regarded just now as a dangerous one, at all events, in an Association of this character. It ap-

pears to me, however, that, although there are many excellent exceptions, there is no department in our great iron and steel trades which is so behind-hand, not only in commercial methods, mechanical arrangements, but also in systematic organisation, and scientific methods as the ordinary foundry. What we want to do in the foundries of this country is to "Wake up," and it is the duty of the Associations such as ours, to waken them up by such criticisms and teaching as we are capable of.

Although we in this country export many thousands of tons per annum of foundry pig-iron to Germany, and other parts of the Continent, yet it is clear that in Germany alone they make something like double the amount of iron castings that we do, and, although there are, as far as I know, no direct statistics available in this country with regard to the production of castings of any sort, yet the ordinary iron castings cannot exceed an output of more than 1½ millions of tons per annum. This is a very small output for a country like ours. It is, however, of foundry methods that I desire to speak more particularly. It has frequently been said in this country by those who are well able to judge, that if you send out to six different firms of founders for tenders for any line of castings, that you would never fail to get one tender out of the six at such a price that the castings could not fail to be made at something less than the cost of production; that is to say, at a loss. There is no doubt whatever that there is a grave element of truth in this statement, and it clearly shows that here, as well as in some other countries, for we are not peculiar in this respect, the organisation and perfection of costing and estimating is in a very unsatisfactory condition, so far as castings are concerned. It appears as if in any ordinary engineering works the foundry and foundry affairs are relegated to a subordinate position, and generally regarded as a hopeless and objectionable, though, perhaps, necessary department. In these days of specialization in the manufacture of products of all sorts, there is no place where systematic organisation and specialisation is more distinctly necessary than in the foundry. The ordinary general or jobbing foundry often attempts all sorts of castings whether suitable or otherwise for it, and this is due, the foundry manager often asserts, to the laymen who controls him and his foundry. Its products are, therefore, so miscellaneous that it is generally hopelessly confused with regard to the detailed cost of its production, and, therefore, is not in position to properly estimate the cost of any particular class of work. The ironfounder, in such cases, cannot, therefore, make out a tender based upon previous experience, except in the most empirical and crude manner. Since I have been President of this Association, I have frequently heard in ordinary conversation with many members, the assertion that the ordinary foundry managers, as a rule, owing to the organisation at their particular works, have not the opportunity to acquire knowledge on this subject, inasmuch as it is dealt with by either managers or officers who may, or may not, be their superiors, but who are themselves laymen in the foundry business. There is doubtless a certain amount of truth in this assertion, as it frequently happens that there is in particular cases a good deal too much layman control about foundry operations. But, after all, the first element in cost-keeping of any importance is within the foundry organisation itself, and I have found it always difficult to get the debts and appropriation inside the shops themselves properly dealt with. It is manifest that when a shop, or to take a larger unit, a whole foundry is continually producing one class of goods of a similar weight and character, that cost-keeping, in such a case, is simplicity itself. But even in the case of large specialised foundries making, for instance, cast iron pipes, in which different weights and sizes may be made in separate but adjacent shops, it is not easy to regularly and properly allocate charges to the different and varying weights and sizes of pipes, inasmuch as considerable and intelligent organisation and care is required to allocate such items, particularly those of general stores and common labour, to their proper castings. Notwithstanding the elaborate and successful organisation obtaining with regard to costing in other branches of the engineering trade, it is rarely the case that this is done with anything like accuracy in a foundry. If it requires a careful organisation in foundries on special lines of work, it is, therefore, clear how much more so it is requisite in the ordinary jobbing shop or general foundry which is on varying work of a very different character. The system has to be extremely elaborate and well thought out, to get the exact cost of each of the different jobs of different classes of castings produced, which can be the only correct system to use to form an accurate basis for sending in proper tenders for

work. It is the practical foundry manager who will have to not only successfully carry out this kind of thing, but improve and elaborate it in all its details. I should like the members to set to work and give papers on this most important subject. It is clearly one which will require much patient investigation, and the foundry requires the gradual application of improved methods with regard to it.

Whilst on the subject of specialization in the production of castings it may be well to point out that specialising in castings will necessarily be one of the features of foundry developments in the future. There is an increasing tendency to confine the manufacture of a particular type of casting to particular shops, properly constructed and arranged for that purpose, or to build the whole foundry for that particular type of casting, and merely use different shops of different handling capacity for the respective different weights. This causes an immense simplification both with regard to cost and cheapness of production under such circumstances, as everything is specially arranged for the particular type of casting to be made, at greatly less labour cost, with immensely greater experience obtained with regard to the making of that particular special article.

There are other matters of organised system in foundry operations which deserve attention. Wasters, for instance, are the cause of much misplaced energy, not to say language, in all foundries, and it seems to me that in most foundries these wasters might be very much diminished by an organised study of them. It is truly and frequently said that the study of errors points out the way to success in the future, and it can be said with certainty that a study of wasters made, is the surest way to their reduction in quantity in the future; therefore, a systematic manner of dealing with the subject of wasters is highly necessary in every foundry. A proper waster book should be kept, and every waster recorded and the number or name of those who made it, together with its type, the cause of its production, or the particulars of any investigation made with regard to it. The number or percentage of wasters produced in every class of work would then be accurately known. The percentage production of every type of waster would also be known. Gradually a mass of valuable statistics would be accumulated, and any fluctuation in them would be keenly noted and studied, and efforts made to remove the cause of them. In no instance would the use and study of statistics, carefully compiled, be better rewarded.

There is still further another practical matter in the ordinary operations of a foundry which requires systematic attention, and that is the proper registration of all the costly tackle used, such as boxes, core bars, and the various other loose plant. It is just as necessary to provide a system for the quick registering and finding of stored foundry tackle as it is to so provide for the drawings in a drawing office or the patterns in a pattern stores. These classified registers not only provide quick information with regard to the actual possession of certain tackle which will be suitable for the specific jobs wanted, as to the quantity or suitability or otherwise, but they form the basis of a ledger account for debiting the cost of new tackle, or for the crediting of scrap from broken up tackle, and therefore furnishing the actual cost of such plant on each or any class of castings with systematic and unerring accuracy, i.e., if the system is carefully and conscientiously carried out.

Perhaps the greatest advance made in this country with regard to foundry work, particularly ironfounding, has been the increased attention paid to the study of the metallurgy of cast iron. I think there is an immense amount of work yet to be done with regard to the metallurgy of cast iron as contrasted with steel, but it is a good omen for the future that so much has already been done, and that not only has a large amount of research work been accomplished, but a great deal is now at the present time in progress.

The advent of the chemist or metallurgist in the foundry has not in every case been immediately productive of better results owing to the fact that the metallurgist has first of all to study the circumstances and conditions obtaining, but more frequently because it is a long time before the foundry manager or foremen are able to appreciate his work. Every foundry manager ought to become such a student of metallurgy, as will enable him, at all events, to apply the work of the metallurgist in a systematic and practical way in the foundry, as obviously the manipulation of these matters must remain with him although guided by the analyses or other work of the metallurgist.

There is another subject which, in my opinion, we shall shortly have to make up our minds about, and that is with regard to the inspection and the testing

of castings, and of the iron of which they are composed. It is true that of late years, in one material or another, the Engineering Standards Committee have dealt with these matters in a very efficient manner; but it is only latterly that materials made of cast iron have been under consideration. It is, perhaps, desirable that I should say here that I have recently been put upon the particular Committee which deals with cast-iron pipes. There is, and always has been, a considerable divergence of opinion with regard to the particular tests which shall be imposed on particular kinds of castings, and the metal of which they are composed, and frequently the tests imposed are not compatible with each other, for, after all, cast iron has not long been a subject for special investigation or research. I consider that in the near future, we, as an Association, must go carefully into this question, because it is quite clear that in our collective capacity we shall probably be able to furnish the most practical and scientific opinion on these tests of any organisation in this country.

In conclusion, I may say that in pointing out a few of the defects existing in foundry system and organisation, I am quite well aware that there exist many foundries above criticism and reproach, and during the last few years we have made immense strides in the direction of improvements in these matters. We do not give place or precedence to any country with regard to the excellence or soundness of our products, and British castings are still the envy of the world. Gentlemen, may we not only maintain that position, but may we also excel in the scientific and systematic methods of production in every way. (Loud applause.)

Mr. R. Buchanan (Walsall): I think you will agree with me that the President has given us a most excellent and suggestive address. I am glad to hear him refer to the question of cost in foundries. It is a subject that has been occupying our minds very considerably for some time past. I have only one grievance against the President, and that is because I was going to work it into a paper of my own. (Laughter.) The President has cribbed my ideas, just in the same sense as it was once said by a man that Shakespeare had stolen all the finest ideas he ever had. (Laughter.) I think except in specialised shops this question of costs has not only been neglected, but, as a matter of fact, there are hundreds of foundries who do not pretend to have even the haziest ideas in the world as to what things are costing. They generally look with a very surprised face when they find that the banking account is dried up. They have to meet their creditors and they have nothing to pay them with. That is not a fancy picture; you can hear of it every month. Regarding some foundries, it is not difficult to predict where they will ultimately land. Meanwhile, it is an enormous drawback that it hinders the man who does know his business from getting the price he ought to have. (Hear, hear.) That is not a matter in which we will differ from one another. We may quarrel with the blast-furnace manager as to whether he will sell by analysis or not. But I don't think we shall quarrel when we say that the labourer is worthy of his hire, and the founder has a right to get a proper remuneration for his work. The man who works under cost is not only an enemy to himself, but to everyone who has anything to do with him. I heartily support the President's remarks regarding the great importance of costs, and we shall try to push it into the heads of foundrymen that they should adopt them as quickly as possible, and not go along by rule of thumb, neither profiting themselves nor any other person whatever. I wish merely to emphasise I concur with the President, and I propose that we thank him for his excellent, suggestive, and instructive address. (Applause.)

Mr. Cook seconded the vote, which, on his putting it to the meeting, was carried with enthusiasm.

The President: I am very much obliged to Mr. Buchanan for his remarks. I have found it not easy to write two Presidential addresses without touching on the second occasion on any point dealt with on the first. But I thought it better to take some such line, as one or more of you have been connected with new developments. Having been so connected myself, I have had to run along a line of this sort with very great effect. The system I have outlined I have in operation, and I know something about it. I am sure if some papers were introduced in our "Proceedings" with regard to this, they would provide valuable material for discussion.

I am sorry to say Professor Arnold is not here. I believe he is engaged in a law case, which practically renders him unable to come. We shall not have the advantage of hearing him. I have pleasure now in calling upon Mr. Long-

muir for his paper on "Practice and Theory."

Practice and Theory.

By Mr. Percy Longmuir, "Carnegie Medalist."

Mr. President and Gentlemen,—I propose examining the relation between practice and theory by taking a few examples chiefly from actual foundry work, but also from metallurgy. In this town there is a large amount of Swedish iron used of exceptional purity. It comes in week by week, the average analysis of which is carbon 0.08 per cent., silicon 0.02 per cent., manganese 0.05 per cent., sulphur 0.01 per cent., phosphorus 0.01 per cent.

There are various brands of this iron, some five or six in all. But, as a rule, the analyses are always the same. If we take almost any brand of the iron, we get results representing a maximum stress of twenty-four tons to the square inch; the elongation is 35 per cent. Any brand you take will give figures in that neighbourhood. You can take any brand as a basis for steel-making, and you get a certain result. You take another and treat it in precisely the same manner, and you get a totally different result. That is one illustration of the difference between theory and practice. Theoretically, these irons being of the same analysis should give the same result. Although the different brands of the same analysis show similar mechanical properties, their actual working properties are totally different. If you take the case of some steel castings, such as usually made, containing combined carbon 0.45, silicon 0.08, manganese 0.48, under any usual conditions you get a maximum stress of 45 tons to the square inch, an elongation of 25 per cent., while a bar can be made to bend to a right angle. You can take two similar heats and you will get similar results. You take castings used in the form of a spur or wheel teeth, the material may be short; and you may take another bar with an analysis having the same mechanical properties, but the result is entirely different. Then if you take an ordinary grey iron containing 0.05 of combined carbon, with 1.7 of silicon, and 0.6 of manganese, with 0.06 of phosphorus, a fairly good type of iron, and you test it daily you will get results varying from 16 tons down to as low as 10 and even 8 tons to a square inch. Figures such as these make us think that after all the relation between theory and practice is not quite so far advanced as the Lord Mayor may give us to understand. Now in any study and in any comparison with reference to foundry work one must refer to the moulding machine. Theoretically, machine moulding is economical in the larger outputs obtained at a lower cost. To a certain extent this is true in practice. Hence, naturally the query arises, why are moulding machines not more extensively adopted. To an outsider this question may seem extremely simple, but the foundrymen may find it much more complex. Given a large run of repeat castings, the matter may be fairly simple, and the actual output may approach the theoretical. But with intricate castings not required in great quantities, the problem is a difficult one, and the question may arise, whether the theoretical economies are worth the capital outlay involved. At any rate, the successful utilisation of machines on a constantly changing class of work is one of the most difficult problems of the foundry, the solution of which would lead us to regard theory as nearer to practice. Another equally striking fact is the difference between theory and practice in the use of fuel. We are all familiar with the fact that iron can be melted with less coke on paper than in the cupola. The calculated ratios, even when allowance is made for differences in conditions of practice seldom hold good, and the discrepancy is obviously due to the fact that the calculation of conditions of practice demand not only molten but suitably fluid metal.

An important part of my work during the last seven years has been in reading metallurgical literature of America and the Continent, and of this country. That is an education, and I believe Mr. Buchanan, in one of his Presidential addresses, spoke of the man who scoffed at book learning. I have a certain amount of sympathy for that man. Taking the foundry side of metallurgical literature, probably no topic has received more attention than that of silicon and its effect on iron. Now previous to 1864, several observers had shown that the influence of silicon was to precipitate carbon in the graphitic condition. Percy's work contains one or two references to that effect. Following upon the work by Percy, various isolated references to this action occur. But it was not until 1885 that Professor Turner published his work on the influence of silicon on the properties of cast iron, and then accurate detailed information was available for the first time. Professor Turner's work is familiar, I take it, to all of us. That work was independently confirmed by Keep and several others, although Keep worked under entirely different conditions. The next result was that Turner's

views gradually and slowly filtered into foundry practice, and we have now what is known as silicon control. In this way Turner's experimental observations have developed into practical fact.

In 1906, Mr. W. H. Hatfield, in a paper entitled "The Influence and the Condition of the Several Varieties of Carbons on the Properties of Iron," discussed the influence of silicon on iron, and published some singular results. I don't think it worth while to go through all the figures. But we might take one or two more typical ones. Mr. Hatfield publishes two series of results. In the first series he starts with a silicon content of 0.28 per cent., and gets no precipitation of graphite. The amount of silicon is gradually increased until he gets 1.1 per cent., and there is a reported trace of graphite. At 1.43 per cent. he represents 0.28 of graphite, and at 1.8 of silicon 2.6 of graphite. A series of tensile results are given, which for the moment I shall not refer to. To confirm that series, Mr. Hatfield made another series of tests in which he started with silicon 1.51 per cent. and carried it up to 3.05. Taking the third figure of the second series, 1.8 of silicon produced 0.11 of graphite, and it is interesting to note that 1.73 of silicon produced 0.1 of graphite. With 0.1 present of graphite this author describes the fracture as slightly mottled. But with 0.11 of graphite the metal is described as full mottled. Taking the few notes drawn from that, we may take it that practice recognises that under certain conditions gradually increased, the increase in the amount of silicon gradually increases the amount of graphitic carbon. Taking these results from the practical point of view, the first series of increased silicon from 0.28 to 1.1 results in the appearance of only a trace of graphite. But with 1.68 of silicon the amount of graphite precipitated is only 0.65. It is also worthy of note that the increase of silicon from 1.68 to 1.72 results in the appearance of 2.4 per cent. of graphite. From the common-sense point of view 1.68 to 1.72 are equal figures, at any rate, as regards silicon, and yet that increment of 0.04 per cent. is, acording to Mr. Hatfield, responsible for the graphite jumping from 0.65 to 2.47, and with that result the iron is grey. Turning for a moment to the second series, we find that with 0.71 of silicon there is a trace of graphite in the iron, which is described as white. With the silicon at 1.73 the iron is described as slightly mottled. In other words, the increase of graphite from a trace to 0.1 results in the iron changing from white to slightly mottled. How the iron could get mottled is a mystery, but much more is it a mystery how the further 0.01 should result in the production of mottled iron. These results have only one common point of agreement in that they agree to differ. In the first series 1.1 of silicon gives white iron. In the second series 1.71 produces white iron. Now in a commercial sense, white iron is not machinable yet these silicon amounts are in iron, thousands of tons of which are used for engineering purposes, and further they are grey, and commercially machinable. Many of them are used for engine parts of great importance. The author found that 0.04 per cent. of silicon caused no precipitation of graphite, that with the 0.11 of silicon the percipitation was 0.06, and that with 0.45 of silicon the amount of graphite was 0.35. Now these are all white irons, every one naturally unmachinable. The other constituents are the same, and it will be noted that 0.35 per cent. of graphite results in white iron, whereas 0.11 per cent. of graphite gives mottled iron in the Hatfield results. Further, we have the fact that the increase of the silicon content increased the graphite even within the range of legitimate white irons. In the Hatfield results, attention has been chiefly drawn to the silicon, and the two series agree only in that they do not agree with any previously published work, and they do not agree with average practice.

In any discussion of theory and practice, we are often told that research work done under works conditions is necessarily better than that done under laboratory conditions. With regard to these series, they have been done (1) by a competent observer, and (2) under works conditions, but we see that the work does not agree with the work of ordinary practice, and neither does it agree with theory.

In 1885 the publication of Turner's research results led to experimental work in the foundry, and the increased importance of silicon control became the leading feature in practical work. Some twenty-five years later, this silicon control was shown to be non-existent, and in support of this two series of results contradictory in themselves were given. No substitute is offered. Any true fact, if only of a rough kind, is better than wandering in the wilderness.

Another aspect of metallurgy consists in the comparatively new science of metallography. Any reference to metallography has special interest at a meeting held in Sheffield. Many years ago William Nicol, lecturer on Natural Philosophy at Edinburgh in the early part of last century,

in the course of experiments conceived the idea of cutting sections of fossil wood so as to reveal its minutest structure. But no notice was taken of his work, which lay dormant 25 years, and on his death his collection passed into the hands of Mr. A. Bryson, of Edinburgh. Mr. Henry Clifton Sorby examined Mr. Bryson's collection, came across this section, and immediately saw the value of this method, and also came to the conclusion that it would lead to important advances in geological theory. I especially emphasise theory, gentlemen. In 1885 a work on microscopical structure crystals was published, and this directed a considerable amount of attention, and also got a corresponding amount of opposition. Nearly every prominent geologist attacked it. Sorby saw that there was no necessary connection between the size of the object and the value of the fact, and in spite of opposition, he carried on his work of microscopic examination, and this led to further studies on which the science of metallography was built. In 1864 Sorby prepared a series of sections of grey irons, wrought irons, steels and so forth, and these sections are preserved to-day in this institution under the care of Professor Arnold. Sections of No. 3 iron prepared by Dr. Sorby were exhibited. They were ridiculed by geologists and long neglected by metallurgists. But the method thus used has now become one of the most practical methods of studying certain aspects of metallurgical problems. Sorby's work was followed by Arnold in this institution. Arnold, in studying a series of exceptionally pure carbon steels, identified the constituents of ferrite, pearlite, cementite. In the first paper I gave before this Association, I referred to this work of Professor Arnold, and you will remember that when the carbon is present to the extent of 0.89 per cent., that the whole of its structure consisted of pearlite. Arnold's work, as with Sorby's earlier work, has met with a lot of discussion, and we have had crude young men, with no training whatever in metallurgical practice, entering the lists and building up theories of their own. Not long ago, one of them published the photograph representing a new constituent, and that new constituent was a piece of towel on the face of the section. (Laughter.) The result of this work has led to the conclusion on the part of a lot of people that micro work is theoretically of no value, and that the majority of the microscopical work published is not theoretical and not practical. In our reading we must winnow the chaff from the grain, seizing on what is true and rejecting that which experience teaches us is untrue. It is said that the microscope is simply an advance on grading by fracture. That is not so. The microscope examines structure. Fracture shows only the appearance due, as I said in my Manchester paper, to the force used in effecting it. It will show a fibrous fracture which is intensely crystalline. Wrought iron can even be made to show a fibrous fracture, whereas the structure is crystalline. That is merely a side incident. One must regard these things as far as possible in a proper perspective. The Lord Mayor, in his address to us, said that in Sheffield the rule-of-thumb was gradually dying down. I hold an example in this wrought iron that the rule-of-thumb still applies, because you have three or four irons identical in composition and mechanical properties, and yet giving totally different results. Science can give no explanation, and yet there is an explanation that has yet to be found.

I mention that because, when I sat down to think out a few things on the relation between theory and practice, I found it very difficult to decide altogether whether one should condemn theory. In thinking the matter over one could compare it to an engineer having to cross a mountain range. The practical man, the ultra-practical man, would break the whole of that range, in order to get a level track for his line. The theoretical man with a certain amount of practice in his composition would survey it on both sides, and he would start tunnelling from opposite sides. The point in meeting might not be exactly true. It might be a few yards or a few feet out. But at that point the tunnel could be widened. Usually theory will help us to bridge over facts, and as our knowledge increases we may find that theory has been wrong, but the points at which it has been wrong can be remedied. Another thing that foundrymen often pride themselves on, is that they are practical and not theoretical. Gentlemen, if the waster is produced in any foundry in this country, the chances are that the reasons given for that waster will be equivalent to the number of men in the shop. (Laughter.) If you take a waster, an intricate waster, not an ordinary or common garden thing, and show it to ten different foundrymen, you are morally certain to get ten different explanations. (Applause.)

The PRESIDENT: Mr. Longmuir has put before us an exceedingly interesting paper, which is now open for discussion. There is no end of material in it for discussion.

and I shall be glad if you will proceed to discuss it.

MR. R. BUCHANAN (Walsall): As you say, Mr. President, the paper bristles with interesting points, and just brings to one's mind the vast Continent, the unknown Continent that lies before the man who wants to study metallurgy. I think sometimes we are apt to emphasise too much the points of disagreement which may arise between what are recognised as known facts, and isolated experiments in some directions. Mr. Longmuir has given us some of Mr. Hatfield's results. I regret I have not read the article. He did not mention whether the iron was crucible iron with silicon.

MR. LONGMUIR: Yes!

MR. R. BUCHANAN: So far as "grey" foundrymen are concerned, these facts do not come within their cognisance, because no "grey" foundryman works with crucible iron, carbon, and silicon. However eminent Mr. Hatfield may be, and however interesting his figures, I say here and now in Sheffield with ten years' experience of working a foundry and melting from analysis, my results covering that period are absolutely different. I must say that my experience is not, and never has been, in any one instance in accord with Mr. Hatfield's experiments. That leads one, of course, to the conclusion that, while no one doubts the accuracy of the truth of Mr. Hatfield's experiments made under workshop conditions, the other constituents of iron with which the ordinary foundryman has to do also play a very important part in producing the results that the grey foundryman knows so well. I shall leave that aspect of the question there with the remark that those results, and I think I may speak for many other foundrymen, are wholly dissimilar as far as grey iron is concerned.

Professor Turner entered at this moment, and was given a very cordial reception.

MR. BUCHANAN continuing, said: Probably the melting conditions obtaining in the cupola account for the discrepancy, but that the discrepancy does exist I think there is no doubt whatever.

Mr. Longmuir had touched on the question of the theoretical output from machine moulding as compared with the practical output. I think we all agree with him. If one has had the job to instil into the minds of what the President called the laymen connected with the foundry, how widely different practice and theory are in connection with machine moulding, I think we shall also agree with him that very seldom does the practice come up to the theory. Speaking for myself, I have found it one of the most difficult things to judge, and decide as to whether a particular job on a machine is going to pay or not. I am afraid the man who knows least about the foundry is often the aptest to adopt the machine. I don't say that is always so, but they have a blind faith that they are going to get a great deal for nothing, and very often they find their mistake.

I was very pleased and gratified to find that a patriotic Scotchman did such good work, and that among other things Scotland produced the man who first made a section for the microscope. (Applause.) I have heard that Shakespeare was a Scotchman—(laughter)—and it was proved by a Scotchman who said he must have been a Scotchman because of his uncommon ability. (Renewed laughter.) I won't go so far as that, but I am very pleased that Nicol, in Edinburgh, gave a lead to that most distinguished citizen of Sheffield, Dr. Sorby. Undoubtedly, before metallography there is a very great future, and no doubt the microscope, as Professor Turner has elsewhere shown, can be, and is being, used as a workshop tool. One can readily see from day to day whether one's mixtures are kept regular or not, by examining the structure, and if the structure is right one knows that the mixtures keep right chemically and physically.

To come to Mr. Longmuir's final point in regard to theory, we practical foundrymen, as we are proud to call ourselves, are a little apt to look askance on the theorist, and yet after all the theorist is a prophet. He may be a false prophet—(laughter)—and he may be a true prophet, but time will test whether he is one or the other. It was the man who scouted Faraday's theories regarding electricity, who made Faraday prove he was right, and in that case theory preceded discovery. I don't know that there is anything more instructive or educative when one is engaged in the business than to try and build up a theory regarding phenomena seen in the foundry, because the foundryman has the widest field for constructing theories, and from his work and his knowledge so gained he can judge whether or not his own and other people's theories are correct. And so I have more patience with the theorist than ever I had, because I look upon him as the prophet, and it is the business of the practical man to prove him either right or wrong. But we, as practical men, ought not to be so ready to take in all we hear,

and all we are told. But we should endeavour to prove for ourselves whether or not the thing is true, and until that is done we really do not known our subject. I must express my hearty thanks to Mr. Longmuir for giving us such an excellent paper. (Applause.)

Mr. F. J. Cook (Birmingham: I should like to join with Mr. Buchanan in thanking Mr. Longmuir for his valuable paper. During the last few years there has come such a flood of science in connection with foundry work that I am very glad to see Mr. Longmuir, who is alike practical and theoretical, taking something from the practical side. One has had pushed upon him so much that the only way to attain success in the foundry is to have theory, and to be a chemist. I am sure there is not one who has to do both with the practical and theoretical side, but soon finds out in daily work that theoretical analysis is not everything. He soon comes up against the experience, which Mr. Longmuir found, of irons having identical analyses with absolutely different results. I have had many of them. I was one who started pinning my faith to analysis, but it soon came unstuck. I have had pig-irons of practically the same analyses giving in one case 16 tons tensile strain, while in another it was impossible to get more than 8 tons. Therefore there is nothing at all on the side of chemical analysis that would put us right. Mr. Longmuir somewhat shattered our faith in chemical analysis, and has not left us with a remedy, and so we shall perhaps be floundering in the wilderness. We have to sell and make castings to give certain physical properties independent of what their chemical analyses are. They are bought on the physical properties, and not on chemical analysis. Therefore it is the duty of everyone who has to produce castings of a high-class character to have not only theory, but a routine of physical tests carried on. Anyone, I can assure you, who makes them, will be well repaid. I have used them in regard to shrinking, deflection, and tensile strength, and I apply these tests to pig-iron, as well as employ chemical analysis. I can say that money thus spent will be well spent, to the great gain of anyone who does it regularly. I suggest that, as practical men, we do the practical part first. I don't wish to cry down chemical analysis in any way, but if a man carries out proper physical tests he will soon want to know more about the chemical analysis, and will appreciate it. I would like to put the two things in conjunction, and if that is done by foundrymen their faith will not be shaken by what Mr. Longmuir has said about chemical analysis.

The President: I am afraid Mr. Longmuir has frightened most of us. I don't propose to take any part in the discussion myself, except to say this, that Mr. Cook touched on one point which was exceedingly suggestive. Anyone who takes routine chemical tests, and routine mechanical tests day by day has in his possession a valuable lot of statistics. There are always castings coming out which don't do what they should. The remedy for this is still further research. If these statistics are kept, some day the reason will be found out.

Mr. Longmuir, replying, said: I had hoped there would have been a wider discussion, and I had intended to give my definition of theory in reply. The definition is as follows:—"Theory should be the most practical exposition of facts." With regard to Mr. Buchanan's remarks, I don't know that there is much to say, and also in regard to Mr. Cook. The remedy has been suggested by the President, namely, further research. I thank you for your hearing.

The President: I have now pleasure in calling upon Mr. Sherburn to read his paper.

Mr. Sherburn read his paper on "The Foundryman, Past, Present and Future."

The Foundryman, Past, Present, and Future.

The published proceedings of the British Foundrymen's Association annual Convention—of which this is but the fourth—as well as the records of the Sessional meetings of the various district branches already at work, afford good evidence of the fact that on their scientific, and perhaps also on their technical or practical side, the problems of the foundrymen are being studied in the serious and matter of fact fashion which we may consider to be a natural characteristic of the Sons of Mars.

The right key-note was struck in the first Presidential Address by Mr. Buchanan in 1904 (which, by the way, will well bear another reading at leisure), the ideal set forth having been kept well in view ever since.

We must all realise, however, that there is another side of the life of a foundryman which has its problems (of a different nature but quite as important) on the solution of which depends—in a very marked degree—the enthusiasm and ability which he will bring to bear on the more material problem already indicated, and which, therefore, come well within the

range of study embraced by an all round, progressive educational Association such as the British Foundrymen's Association.

We are ever being reminded, both from within and without our own individual consciousness that the foundryman is a "man" as well as a founder.

If the "man" is uneasy, debased, or discontented, the "founder" will be inefficient and unsatisfactory, be he manager, foreman, or craftsman.

In the ideal foundry—for which we are all striving—inefficiency will be intolerable, hence the absolute necessity for harmony between the "founder" and the "man."

To assist in the promotion of such harmony is the reason for my choice of the subject, "Foundrymen, Past, Present and Future" for this paper, to which I might add the sub-title, "A Plea for the Human Factor."

We are members of a craft of which we have all good reason to be proud. Let us claim our birthright and live up to it. From our great master, Tubal Cain, right down the ages we have a noble ancestry. We are heirs of all ages and all nations, although we are apt to sometimes forget the latter relationship.

We have often been told that the state of civilisation of a people may be judged by the extent to which iron enters into its service. One need only try to imagine, if possible, our country to-day without iron in any form, to realise in some measure the value of this very common metal, and, of course, as an inseparable consideration, the value of its workers.

Its discovery and earliest history is veiled in mystery and romance.

Astrology gives us a worthy position as the "Children of Mars." History tells us of the high value put upon the iron-worker in ancient times, the most coveted prisoners of war being—not the princes, officers, or soldiers—but the smiths.

We are told that the smith was a privileged person in high social circles, the "spark in his throat" needing, and being allowed, the richest and most liberal draughts of liquor from the Royal table; and how at one time also the kitchen utensils were numbered amongst the State jewels.

Fascinating, however, as the ancient history and romance of our craft undoubtedly is, and worthy of occasional review, our present consideration must necessarily be confined within narrower limits.

As mechanical facilities for the easier manipulation of our craft are being daily multiplied, however, it is to be feared that the human interest taken in the work by the craftsman and pride in the results achieved, are on the wane in seemingly inverse proportion.

Thus it is that because this problem has presented itself to me in all its seriousness so frequently of late years, I ask your consideration of it for a short time at this, our Foundrymen's Convention.

We are all philosophers to-day in the belief that useful work—as well as being worship of the truest kind—is the greatest blessing of life. What makes it irksome, when it is so, is that, individually, we have either not found our right work or we have not yet seen it in its proper light.

We each do our own particular work for one or all of three primary reasons:—

1. To gain the means of living.
2. Because the things we can do are wanted either by ourselves or others.
3. Because we love to do or produce some particular thing for its own sake.

When all three reasons inspire us in fair proportions we shall doubtless be happy in our work. In proportion as one or another reason predominates or is lacking, will be the measure of uneasiness, discontent or unhappiness we shall experience.

Our business then is to endeavour to harmonise these conditions, or to find out the cause of the discord with a view to its removal.

That harmonious conditions such as I have suggested did prevail in the lives of the industrial pioneers of history is, I feel sure, amply proven by the records of their lives and labour, which have been preserved to us, and here I would pay a tribute to the memory of good Samuel Smiles for the interesting and sympathetic manner in which he untiringly laboured to gather and preserve for us so many of those inspiring pictures of the early struggles of many of the pioneers of our craft.

He there shows us, unmistakably, how these persistent workers—spite of all the perplexities and disadvantages of the time—found much happiness in their work, were, in fact, right proud of their craft, and followed it with the same devotion as the painter follows his art or the poet his muse.

It was such a spirit, doubtless, which animated Abram Darby when, after his visit to Holland—200 years ago—to learn something of the secret of iron cooking-pot making, he laid the foundation of the still famous Coalbrookdale Works, being followed by that fine old character, Richard Reynolds, who on Darby's founda-

tion, reared the superstructure of a great industry which has an unbroken record to which all foundrymen may refer with pride, and which is being to-day conducted with renewed enterprise promising well for the future.

So likewise worked (not far from Sheffield), the Walker family who, from a small beginning in a nailer's smithy at Grenoside, 160 years ago, rapidly covered the neighbourhood of the historic town of Rotherham with iron industries which became world-renowned, and which still retain some of that ancient fame. The brothers early acknowledged their responsibilities other than material by the erection of elementary school buildings for the children around their works.

The same spirit led that honoured native of Sheffield, Dr. Roebuck (grandfather of Sheffield's old Member of Parliament, the independent John Arthur) to establish in Scotland a few years afterwards the great Carron Works, also still doing good work and giving promise of a renewal of its youth; and at the same time to befriend James Watt at a very critical stage of his work.

It also led William Murdoch to spend many years of a most busy and inventive life, in a noble self-sacrifice in order to stand by the less robust James Watt, shield him from many troubles, and help him through with numerous devices.

This fine character has yet to receive the full honour which is due to such a splendid example of devotion of his craft.

So worked Benjamin Huntsman, William Fairbairn, James Nasmith, Joseph Whitworth, Henry Bessemer, David Mushet, and very many others who, although less known to fame, deserve none the less honour, and to whose perseverance, genius and grit we owe much of our present enviable position.

A notable characteristic of these early craftsmen was that they wrought in close touch with their assistants and their apprentices, forming together one compact body of "foundrymen," the master, indeed, realising and meeting his responsibility as guardian, as well as teacher, of his apprentices, and as elder brother as well as employer to his workmen.

This town and district of Sheffield can furnish many good examples of this latter type of employer from last century's record of her industrial worthies.

That such human relations as these have been almost banished from the foundries of to-day beneath the heavy tread of modern "commerical progress" will scarcely be disputed by any thoughtful founder, and while acknowledging the wisdom of a natural evolution which tends towards larger combinations in the interest of general economy it appears pretty certain if the worker's pleasure in his work is vanishing while facilities of production are being multiplied, some important factor is being omitted in the process of "speeding up."

This factor will have to be rediscovered and happiness again be installed before we can truly hold up our hands and claim to be making real and permanent industrial progress.

Coming to a closer consideration of the general situation in the present, what do we find?

In the place of what we might call the "home industries" of, say, 100 years ago (for they often had the freedom of action and lack of strict system which characterises home life), and the large and more orderly, yet still unconventional, foundries of 50 years ago, with conditions and associations such as I have already endeavoured to picture, we have concerns of much greater magnitude planned and equipped in every way with a strict regard to systematic work in sectional order, subdivided into as many departments as speedy production proves to be necessary, with a head over each department, and as many foremen under each head as the separate branches of specialised work demand.

These heads of departments, termed the staff, constitute an informal sort of cabinet with whom the chiefs or directors consult in a more or less confidential manner, according to the height of perfection to which that particular concern has arrived. Book-keeping, time and wages checking, etc., are modelled on the same high level of organisation.

Now all this is right and in obedience to the laws of experience and evolution under which all progress is made.

No one will, however, claim that the results are in every way perfect. We shall agree, I think, that, generally speaking, there is a lack of that feeling of real personal association of the worker with his work which I contend existed under the less systematic and formal working of olden times. This is what now calls for our serious consideration with a view to a remedy.

There are several changes which this evolution in procedure seems to have brought about which claim consideration.

1. The wide separation it has made (perhaps unavoidably, perhaps not) between the chief and the ordinary worker, to the disadvantage of both.

2. The almost total abolition of the apprenticeship system from our foundries.

Whatever faults the apprenticeship system had, the present "no system" is a very much more serious one.

By the temptation of higher wages in youth, decent craftsmanship has been degraded, and our foundries are overflowing with "hands" too good to be called labourers, but too poor workmen to be called moulders.

That something ought to be done either by a revised apprenticeship system, or by some group instruction in the moulding shop under working conditions by a practical foreman, or by a combination of the two, will be, I feel sure, the opinion of every true foundryman.

3. The introduction of moulding machinery has had the effect (which under proper conditions it ought not to have had) of lowering the status of the moulder in whose line it has been introduced.

Here we are brought face to face with two perplexing problems—perplexing because opposing. On the one hand, see the bent back and the daily fatigue of the moulder of, say, flat plate work.

Some of you who are sons, and perhaps grandsons of moulders, as I am, know what that meant, when father and mother were often heard to declare, "None of our lads shall be moulders;" and on the other hand, where mechanical aids are introduced for the purpose of lightening this painful drudgery, the moulder must naturally—under present conditions—oppose it with all his might. Oh, the pity of it!

As if the labour of shovelling sand and lifting boxes was essentially speaking, moulding! Yet if it means, as is often has done, that by such a change his occupation will be gone (a labourer replacing him), little wonder at his opposition.

This is one of the sacrifices which ever seem to attend the path of evolution. But could the sacrifice not be shared more reasonably?

Another effect of large combinations has been the total alteration in the character of the work to be performed by the chief who, if he happen to be a born foundryman, with a love of his craft in his blood and a burning desire to devote his thoughts and work to the problems which ever await the inventive imagination, man, with a love of his craft in his blood mercial details ever haunting him, and which may easily become as monotonous to him as the mechanical drudgery of another kind is to his employé.

May not this in some measure account for the feverish anxiety often shown to get away from business to golf, club, or some other diversion, anywhere away from the eternal hum of the foundry. Maybe!

Now as to the remedy.

How much easier to find the faults! However, I will briefly point out two ways by which I think happiness may be increased, and harmony be restored, one acting directly and the other indirectly.

The first would be to add the link now missing in the new order of things, viz., the human factor, by making each unit a real part of the body industrial.

As the smaller bodies of 100 and 50 years ago were able to approximate somewhat to the ideal, so may we, by taking careful note of the conditions necessary approximate still more nearly to the ideal, even in the larger body.

We do not too frequently quote scripture in our foundry literature, but there is one lesson from the teaching of the Apostle Paul which is as applicable to my situation as to any situation in life, so that I may venture to use it confidently and reverently in this connection.

I refer to his fine illustration in Corinthians 12th chapter—of the body and its members—we remember it. How the whole body depends for its health and happy life on the health and happiness of its meanest members.

Are our foundries constituted with this in view at present? Is not the body often working at one thing, the mind on a totally different one?

We know, alas! that seldom does the desirable harmony exist. Rather, the eye too often ignores the hand, the foot the brain, and so on with results which are regrettable, but natural.

If the blood is being drawn from the heart by two or three strong members, or even sucked from the body by suction from outside itself, to the impoverishment of minor but vital members, we need not be surprised if harmful results follow.

I can now safely leave you to complete the comparison and draw the moral. This indicates the direct remedy. Now for the indirect one.

This is found in the wider co-operation, other than financial, of individuals for mutual discussion of the problems which they are separately daily meeting in practical work; keeping also in mind the social and personal communion, which is no mean factor in a full development.

I now refer, of course, to the formation and fostering of Associations such as the British Foundrymen's Association, with Branches in every centre of the industry large enough to maintain such.

With due appreciation of our national

prestige and position in the foundry, I venture to suggest that we, as foundrymen, may learn something in this matter of Associations from our cousin, or shall I say daughter, across the water—I mean, of course, the United States.

Many of you, I know, are as familiar as I am with the work carried on in the various American Associations, both local and national, during the last 10 to 15 years; and have watched with interest as well as profit, the splendid progress there made—progress which, I am afraid, sometimes makes our own efforts seem feeble indeed.

For my own part, I wish here and now to acknowledge the deep debt of gratitude I owe to her literature, especially to "The Foundry," for the entertaining manner in which that journal has catered for its readers, searching out from all quarters and giving freely and lucidly, and withal in an entertaining manner, the best which could be found in progressive industry; and here lies the secret.

By working vigorously in close cooperation, both the journal and the Association have reached the high water mark we see in the current number, and read of in the report of the last Convention.

Cultivated by the persistent advocacy of "The Foundry," the whole industry seems to have realised the benefits of association, and the higher truth that "Giving the best information shall not impoverish, neither withholding enrich," but that a free interchange of light and knowledge is best, both individually and collectively.

We in Britain, now have the nucleus of both association and literature. We can scarcely yet claim more, but let us go and do likewise.

I have left unsaid many things that I intended to say, but other opportunities may arise in due course. If, however, I have led you to think on this problem, you will follow it in the direction of its solution.

The PRESIDENT: You will agree with me that we are indebted to the Manchester President, Mr. Sherburn, for his interesting paper. I am glad he has suggested something with regard to the training of moulders. There is no more important problem before us than that of the old apprenticeship system which has fallen into disuse. That is very much to be regretted, and it is doubtful whether we shall get back apprenticeship to any large extent in future. It is a question that will have to be faced if we are to produce a better average sample of moulder. I can endorse everything he has said with regard to the American Association, and especially I do admire them for the great range of subjects they introduce in their papers. Some of us are afraid of bringing forward what you might call an ordinary subject. But they bring it forward, and they get most interesting discussions. I hope some of our members will copy their example in that respect. I understood the American President was likely to be here; if he is here we shall be glad to hear him.

There was no response to this inquiry, and the Chairman invited the meeting to proceed with the discussion.

MR. BUCHANAN: I wish to correct what I said in discussing Mr. Longmuir's paper. I took it that Mr. Longmuir was referring to Mr. R. A. Hadfield, but I understand now he was referring to a paper by Mr. W. H. Hatfield, of Messrs. Crowley's, Sheffield. I want to make that correction, and I should be sorry if anyone should be misled.

MR. R. MASON (Birmingham): You will all agree that Mr. Sherburn's paper has been a very valuable one. On this occasion we have had a paper dealing with the human side, whereas in the past we have had papers dealing with the commercial side. He has rather called attention to the necessity of building up the man. We all feel that we should do something, but we are all tied, and can't do it. Look at it from the manager's point of view. He feels at times how much he would like to raise the man. He sees men struggling along and trying to do their best; and on the other hand, he finds others who forget all they should be doing, and who only think about going into the publichouse. Do we do anything at all to prevent them from going there? I heard Professor Turner speaking some time ago of what he saw in America. He was greatly pleased with what masters had done there in putting up baths and washhouses, and so giving every opportunity to men to wash and clean themselves. That would tend to make the men have less craving for drink. When a man comes out of the work sweating and dry, his first craving is for drink. He has had no food for hours, but if he was washed, towels and soap being provided for the purpose so that he could go and get clean, he would be less likely to want drink. How many of us are doing anything for them? The foundry in most cases is a dark, dismal place. Any place in the works is good enough for the foundry. You and I should be doing something to better that and to alter the conditions altogether.

The Professor, on the occasion I refer to, said he had mentioned these things to some Birmingham manufacturers, some of whom said that the workmen stole the soap, and all that kind of thing. (Laughter.) Well, the Professor answered that if the men stole the soap that would be the fault of the men, and not of the employer; and possibly if the practice were kept on the men would grow better of that in time with the effect that we would be raising their character.

With regard to wasters, you know that in many cases no words are necessary with some men who have made a waster. You don't need to say a word to them, or if you do say something it is only necessary to remark that they will do better next time. But a lot of people lash away with their tongue, and I know I am not free from that myself. (Laughter.) I think we should realise that a man of that type feels disgraced when he has made a waster. But there are some men who don't care, and who are only waiting and caring for the time when the working hours are up. That man may require to be lashed, but we have to discriminate between one man and another. The real test of the foundry manager is that he can tell which man should be lashed, and which man should be helped up, and our sympathies should be with the latter man. Help the apprentices by all means, but don't neglect the older men.

With regard to the drinking question, there is a great deal of drinking among women, and some people say more than among men. It is coming to be a national calamity. But what starts it? There are more women at work in factories than ever before, and when women go into factories, and find nobody helping them in any way, we find them taking up men's dissipations. That shows us that the men are not to blame altogether. Why are they dissipated? Because of the conditions of work. The reason why women take to dissipation is not because they want to do so, but because of the conditions in which they are placed. There is no need to point out that it is a disgrace to the country that we should be going backwards and that people should be getting worse. For this you and I are greatly responsible. Are we doing anything to keep them up, or anything to alter the conditions? This paper is very suggestive in that light, and it behoves us to see and consider if we can do something for the workmen, and to set about doing it.

Mr. J. Poole (Birmingham): I have listened with considerable pleasure and some profit to Mr. Sherburn's paper. There was one thought he gave expression to in relation to the moulder's occupation. He said that the moulder should be an artist. My opinion is that the moulder is an artist, and there is no occupation which calls forth to a greater degree the use of the senses than the moulder's occupation. No moulder is a moulder without a keen eye. He must have perception and a sense of touch, and in a good many instances the sense of hearing. I think every one of us ought to try and encourage our fellows to look upon their art as a noble art, an art they ought to be proud to be engaged in, and so by that means bring them up to a higher level; let them think their occupation is an occupation that is worthy of any citizen being engaged in. With this thought in their minds, there is no doubt we could help to drive away this indifference on the part of our fellows engaged in the same occupation. The result would be that instead of being untidy and careless, which I am sorry to say a good many are, they would begin to take a pride in themselves, and regard their occupation as being more desirable than in a good many instances they think it is now.

Another matter was the use of the moulding machine. There is no doubt that the indifference displayed by many moulders can be traced to the introduction of the moulding machine. I am not going to decry moulding machines, but I do say it is a shame, and a lasting shame, that instead of the moulding machine being a help to the moulder to elevate his toil, it increases it alarmingly. (Applause.) With that increase of pressure upon his system, a man becomes more indifferent If a man could be induced to take a pride in his work, knowing that if he was going to work a machine he would have some compensation in less labour, he would be more reconciled to it. But the only thing he has got to look for is increased labour, and increased effort breaking down his system. The strain is such that it is almost impossible for the human system to maintain it for long.

I am pleased with Mr Sherburn's paper. It will send us home with food for reflection, and it will induce us to give more attention to the requirements of our men. With regard to the youths, there is too much indifference among a good many foremen as to what these youths are to become. It seems to me so far as my experience goes, and I have been in large concerns, that all many foremen think about in regard to a youth is keeping him

in one particular position, and getting as much out of him as possible. It never seems to strike them for a moment that by so doing they are reducing the chance of these boys becoming accomplished moulders.

Mr. J. Smith (South Shields): I have been very much delighted to hear the paper. Sometimes a man when he gets to a Conference or Convention hears a lot of something that is foreign to him. But I must acknowledge that in Mr. Sherburn's paper there is not a lot foreign to me. But when you come to the practical side of the paper you sometimes get left, and there are many suggestions that you would like explained. It strikes me forcibly with regard to both these papers, that we shall have some difficulty in putting them into practice. The foundry manager has so much in his head during the time that he is in the foundry, and certainly a good many have not time to carry out such suggestions as Mr. Sherburn has explained if they are to manage the foundry. It may seem to you rather strange to say so, but I find from six o'clock in the morning until I go to bed at night I have got something to think about as far as the practical part of the work is concerned. There is the management of the men, and there are the different methods of making different castings that you have through your hands. In the place I am at now I have marine engine castings, turbine castings, and castings of all descriptions, and it takes me all my time as far as I can to see that this work is carried out practically.

I have often heard it suggested, and it has been suggested here, that we should do away with the wasters as much as ever we possibly can. (Laughter.) I have heard that said over and over again, and people ask why should wasters be made in a foundry? I have heard that said by non-practical men, but never by practical men. But I have never yet heard it suggested by a non-practical man how we are to be able to do away with them. I have often heard it said that if these castings are right the first time they ought to be right the second, and I have replied, "Well, now can you suggest a way in which we could make them better?" but never have I been given a suggestion how we should do away with them. As far as theory is concerned, it is said the manager should have more to do with the furnace; it has been suggested that I should be five hours a day at the furnace. If so the balance would be on the wrong side. If you have 150 men, and spend too much time with the furnace something will go wrong. In conclusion, I may say that the paper has been very interesting to me.

Professor Turner (Birmingham): We have been very much interested with the paper that has been read, and several speakers have already expressed their pleasure and satisfaction. I have been reminded that iron-founding in any form is not a new thing, and we have had experience of it for many generations. We know that the old Ninevites and the old Israelites among the early nations produced original work, some of which is preserved to us now. When we come to the Middle Ages and take their work into our hands, very often we feel wonder and admiration for the skill of the craftsmen who could produce these things, such as we have several specimens of at South Kensington Museum and other places.

We in this country pretty generally honour the iron-maker. But there are some few countries where the iron-maker is considered almost as dirt. In India, for example, the iron-maker is low caste. He is a pariah, and nobody thinks anything of him, although the iron industry has existed so long in India.

In connection with the subject, we have to consider the practical work of the foundry connected at the same time with the well-being of the men. We have to look at it from two points of view. There is first the more or less philanthropic question which applies somewhat to the employer of labour, for it is obviously to the master's own advantage that the men shall be healthy, skilful, strong, and contented. Apart from having good men, of course, the employer cannot get good work except under those conditions, and obviously the first thing if we are to have good men is that we should give them reasonable wages. Apart from that, we don't retain good men, if we don't give them that which will support them and keep them strong. Besides that, we need to give them health and opportunities to maintain health by good surroundings.

I have spoken, as Mr. Mason said, about the working conditions, particularly in foundries, and one knows that with very little money and with a little care the conditions of the foundry could often be much improved. In connection with the drink question, I attach a good deal of importance to cleanliness, and I know that drinking is sometimes the result of physical weakness. The man who takes to drink is often more to be pitied than blamed, and you want to keep them from the tendency rather than try to reform them after being more or less lost. No doubt

when you go from this room you will be feeling thirsty—(laughter)—and the simplest way to alleviate that thirst is by a drink. But if you can get a man to wash his hands and face and soak his hands for a few moments, it is astonishing how he is cooled and relieved. The ordinary man goes rushing off from his work to get home to dinner. He lives a quarter of an hour away, and he only has time just to get his dinner and rush back again. The most successful way to get men to properly utilise lavatories and to encourage them to cool and cleanse themselves is to allow a minute or two out of your time. The bell should ring two minutes before the stopping time, when every man drops his work. But they should not be allowed to go out for two minutes, and in the meantime every man is expected to cleanse himself. (Applause.) There may be other means, but that is a simple way.

All these social questions hang together, and have to be dealt with over a wide field. There is the other side of the question, and that consideration deals with men who are iron-founders. We want in the iron foundry competent and, as we have said, skilled and willing men, and you must educate the young if you are to educate efficiently. You know in the case of language, how quickly a child learns, during the first two or three years, its own language. A man at thirty-three years of age to sixty years would not learn in three or four times the time. I remember one of my little daughters was just learning to speak when a Dane came as a student at the University, and he came to my house. At the end of about a year he said to me one day, "It strikes me as being very funny that I have been doing nothing but learn English for one year, and I know nothing, and your little girl can speak anything." The explanation was that the little girl was at the age to learn. She picked it up partly because she had nothing to unlearn. The man had been working hard at unlearning.

In regard to these young people, you must provide instruction relatively elementary, and encourage them to come to the technical school. Having the school, it is the master's duty to see that the young people are taking advantage of the instruction they can get; the youth ultimately becomes a man, and then you have to deal with him as a man.

The old craftsmen did excellent work in their time, and their guilds were immensely useful. It is a pity they have passed away, but they have been largely replaced by societies such as this. We want this Society to progress; but the annual meeting is altogether insufficient. In fact, you come together partly for social benefit. You want large local branches, and to be as far as possible successful you want membership of this Society ultimately to depend more or less upon a form of diploma of qualification. At present you want everybody to come into this Association, but as yet it is not one-tenth as large as it ought to be for the country generally. When the time comes, and the Society gets stronger, we should be able to require a certain qualification for memberhip. If we can do that, and make the Society strong enough, and in the meantime make it so worthy that other men shall have a desire to come amongst us because we are doing something good and useful, then I hope that in this industry the Association will largely take the place of the old guilds. Don't let us be satisfied to see our American friends doing so much better than we are, but let us try to make our Association as good as theirs, though we are somewhat behind now. (Applause.)

Mr. F. Howe (India): I must confirm Professor Turner's remarks about caste in India. Iron-founders are a menial caste, different from the men supposed to be educated. In regard to education, even in this country we are behind America. We have no National College as they have. They are the pioneers of the foundry world, yet I hope that the time will come when we can introduce an organised system of education for our special line suitable to the requirements and difficulties of our trade, where it will be possible to obtain a scientific and technical education. Much has been accomplished by the founders of the Association, and their work has resulted in great progress being made during the last three years. Great credit is due to those gentlemen, and to those who have been arranging and preparing papers for this meeting, so as to facilitate discussion and study, and to improve the system under which we are working.

Mr. Mather (Essex): I must add my testimony to the instruction I have derived from the paper. The condition of our workers in the foundry is a very important question, and I think we should begin at the bottom with the apprentices. If apprentices were recognised in a formal way, so that they might feel attached to the foundry, then they might realise that they would derive special benefit in after life from their apprenticeship. We could lay hold of those boys and they would not only become better men as craftsmen, but better citizens. I, to-morrow, hope to go

to Newcastle-on-Tyne, to take up the privilege in the city of Newcastle that my father has handed down to me. I have to receive from the Mayor of Newcastle those civic privileges as a citizen of Newcastle. Some such feeling might be engendered if we could give the youths something to aim at, such as a certificate from this Association to the effect that they are qualified members of the craft as moulders. That would be a splendid opportunity to raise the standard of our apprentices.

As regards the public-house, I believe the love of the public-house is engendered among the boys in the earliest stage of their work. When we were at Manchester I was delighted to hear one gentleman present from Salford say that nearly all their men were teetotallers. I thought that was a stepping-stone upwards towards raising the standard of the foundrymen. I remember when I was living in Sheffield, as far back as 1874, the men were much more degraded then than now, and I am thankful that through education men are beginning to live for something more than hard work and a drop of beer.

I would like to propose a hearty vote of thanks to these gentlemen for their papers, for reading them, and for the time they have spent in their preparation. (Applause.)

Mr. F. W. Finch (Gloucester): I should like to second the resolution of Mr. Mather. Some remarks were made by Mr. Sherburn to the effect that in the olden time there was a good old feeling of love between employer and employed. I am pleased to say that has not entirely died out. In taking my present position seventeen years ago, I found that my employer had not been getting on as well as could be wished, and I set to work to create a good feeling between master and man. I talked to him a good deal about it, and asked him to take an interest in the men, and he has done so. For the past eleven years every man on August Bank Holiday Saturday has received two weeks wages on the top of his week's money. That shows that there is some of the good old feeling between employer and employed. I shall go back, and try to get him to adopt baths and wash-houses to help to keep the men clean. That paper has done me good, and as a manager of men I shall do more than I have done for the past seventeen years, if possible. (Applause.)

The vote was heartily carried.

Mr. Sherburn, replying, said: I am amply repaid for any trouble I have taken in preparing the paper by the knowledge that I have touched a responsive chord in almost all your hearts. This was voiced first by Mr. Mason, and then by other speakers afterwards. In reply to my friend, I tried to give the idea that these old moulders did work in the same spirit as the artist works at his picture, or the poet works at his poem, and we want to get that spirit back again. At a Manchester meeting, the position of the moulder, and the way in which he was regarded was expressed by a story equally ironical and forcible. A man was speaking about an incarnated donkey. The story goes that a man was driving a donkey pretty heavily laden, and the animal got on until he came to a hill, when he jibbed, but the man whispered something into the donkey's ear, the result of which was that he gave another pull. The spectator was curious, and he said to the man: "What did you say to him?" He replied, "I told him if he did not pull I should send him back to the sand heap." (Loud laughter.)

Another difficulty we have found is that the moulder who is proud of his craft has an objection even to our discussing these matters, and suggesting moulding machinery in our meeting. One member said he did not think we should waste our time in discussing moulding machinery, because he thought we were there to improve our craft as moulders. Well, that is the difficulty, we find. I believe the mischief that is being made in the application of machinery is this, that in a great measure, instead of that machine being looked upon as a tool of the man who uses it, as a tool for the moulder, it has been used as something to put him out of his place and replace him by a labourer. That is not the right use of a moulding machine. The moulding machine, or any other machine, is a tool for the man, and we still need a brain to use it. The mistake has been made that the chiefs have only been introducing the machine to make more profit out of their work, and the question of profit has been carried too far. The public have got the profit out of all the improvements that have been made, and I don't think that should have been. It should have been in the first instance the worker who should have had the advantage. At any rate, he should have had sufficient time to adapt himself to the new conditions which may arise through the use of that machinery. I thank you all again for your vote of thanks, and I am glad that this subject has touched such a responsive chord, and I hope it will work for the benefit of all of us and also for our craft.

The meeting then adjourned.

WEDNESDAY'S PROCEEDINGS.

Practical Demonstration of Pyrometry.

The proceedings were resumed on Wednesday morning, Mr. H. Pilkington again presiding. A visit was paid to the Metallurgical Department for the purpose of witnessing a practical demonstration on pyrometry, by Mr. T. Swinden, Mappin Medallist, and 1851 Royal Exhibition Scholar. Mr. Swinden is one of the most brilliant of the younger section of metallurgists, and last year gave a most informing paper on "High Temperature Measurement." The demonstration now given was intended as a supplement to the earlier paper, and especially for the purpose of exhibiting pyrometers, of which a verbal description was then given. The opportunity of inspecting the instruments and their working was taken by all the members present, and Mr. Swinden showed the method of operation in the seven or eight different kinds in use by the department. Fullest opportunity was given to answer questions, the answers to which were equally lucid and helpful.

Mr. Swinden pointed out that the matter of choosing a suitable pyrometer was not so much a question of deciding which was the most accurate, for the reason that all were reasonably accurate. It was rather a question of the most convenient application of an instrument for the specific requirements to be dealt with. An ever-present consideration also must be whether the cost of installation and upkeep was going to be repaid either by lessening the working troubles, economising furnace expenses, or improving the quality of the products.

Mr. Swinden called special attention to the standard Le Chatelier apparatus. This was installed in this Institution in the early nineties by Professor Arnold. Notwithstanding the enormous developments which have been made in high temperature work, this identical apparatus still holds the field as producing the finest recalescence curves yet published. The durability and reliability of such an apparatus is beyond question. The demonstrator explained the construction and uses of this apparatus in some detail. It embodied, said the speaker, all the fundamental principles of thermo electric pyrometry. There was first a thermo—couple—in this case of platinum, and platinum with 10 per cent. rhodium, made by twisting one end of each of the two wires firmly together. This end formed the "hot junction," and at the other they joined up to the galvanometer leads. It was the *difference* in temperature between the "hot" and the "cold" junctions, which produced the effective E.M.F. actuating the galvanometer.

The main thing to watch was the galvanometer. A good reliable instrument was absolutely necessary, and having got that, all was fairly plain sailing. It must be a dead-beat instrument, *i.e.*, the needle must take up a new position on passing a current, without swinging to and fro for half a minute or more. The galvanometer could easily be wired up through a switch to serve any number of couples. The figure showed a wiring for two couples. Then for any one of the couples, given similar wires for the thermo junctions, the same scale reading for the same temperature will be got.

The question now arose how could they convert scale readings in millivolts or in millimetres into degrees Centigrade or Fahrenheit. It was in the ease with which this standardising or calibrating could be performed that the thermo-electric scored heavily over the resistance and optical instruments.

The most satisfactory method for the every day worker is to note the scale readings given when the H.T. is at known fixed temperatures. The following could be very conveniently used:—

Boiling sulphur (445 C.), boiling selenium (690 C.), solidifying lead (327 C.), and solidifying silver (962 C.).

The scale equivalent in degrees could then be marked off, and if necessary a calibration curve plotted. Then to test the instrument for deterioration at any future time, one or two tests such as the sulphur or lead points would be ample to detect any serious error.

They had, then, with one galvanometer, any number of couples situated at different points about the works, controlled at will by the switch near the instrument. A word might be said about the cold junction. One objectionable feature of the "pokers" supplied with the portable form of thermo-electric pyrometers, was in the fact that when in use the head, which formed the C.J. became very hot. Of course, for anything like correct reading this C.J. temperature must be measured and added to the galvanometer reading.

The plan adopted there was to keep the junction in a jar of water, the temperature of which could be measured with an ordinary thermometer.

The portable instrument of R. W. Paul would be seen to be extremely handy and useful. It was very reliable. That apparatus tested by the method mentioned above was correct to a degree at 960 C., working with a C. J. correction.

The instrument by Messrs. Baird & Tatlock was of a semi-portable nature, and was more suitable for a laboratory or office, than rough furnace work. Either could be satisfactorily installed, as previously described, as semi-portable instruments.

For annealing, heat treatment, and general work, a thermo-electric pyrometer could scarcely be equalled. However, there were some cases where their application was entirely prohibited, and others where they were not at all suitable. Reference was made more particularly to the temperature measurement of molten metal, casting temperature, and of inaccessible positions in a furnace. For such work, a radiation or optical pyrometer was almost indispensable.

The Wanner, and Mesure and Nouel, represented the optical instruments. In the first case a standard colour was matched by the body under observation, and in the second a special "sensitive tint" between red and green was looked for. Thence from dial readings the temperature could be found.

A more recent and more useful pyrometer was that of M. Féry, which utilised the radiations from the heated body and measured the temperature by focussing them on to a small thermo-couple connected to a direct reading galvanometer. Distance away from the heated body did not interfere, provided the area under observation was not too small, and the atmosphere was tolerably clear. The Féry was unique among radiation and optical instruments in that a continuous record could be taken just as with an ordinary thermo-couple. The Siemens water pyrometer, although less scientific-looking than the others, was capable of very good work where intermittent readings only were required. A standard ball of copper, iron or nickel, was heated to the temperature required, and then dropped into a pint of water. The rise in temperature of the water measured the temperature to which the ball was heated. Brearley's Sentinel, Seger Cones, etc, were also of use within a restricted range.

The Uehling pneumatic pyrometer, with recorder, which had achieved such a success for hot blast work, and which was there used in connection with a Clinch Jones heat treatment muffle, was in full swing.

One of the most interesting pieces of apparatus was the Brayshaw salt bath furnace for heating expensive tools for hardening. The baths were controlled by means of Whipple temperature indicators, using a resistance thermometer.

After the demonstration, the Convention re-assembled in the Department of Science for the reading of the remainder of the papers.

The PRESIDENT: I have received a telegram from Professor Arnold, who regrets that business in London in connection with an important law case prevents his attendance. Without further formality, we all agree to pass a hearty vote of thanks to Mr. Swinden for his demonstration. I now call upon Mr. Houghton to read his paper.

MR. E. HOUGHTON, F.C.S. (Chesterfield) proceeded to read his paper as follows:—

SPECIAL FERRO-ALLOYS.

Available for Use in the Foundry.

The manufacture of the ferro-alloys on a commercial scale is only of comparatively recent date. They were brought into prominence first on the introduction of the Bessemer process for steel making, and the alloy which first became important was the alloy of iron and manganese.

As is well-known, the steel first produced by Sir Henry Bessemer was useless on account of being red short.

It was soon found that the panacea for this ill was manganese, and it was supplied by the addition of an alloy of iron, manganese, and carbon, termed spiegeleisen, obtained from Germany, and containing about 10 per cent. of manganese and 4 per cent. carbon.

This was the richest alloy at the time available, and its use in sufficient quantity to overcome the defect just mentioned introduced so much carbon at the same time that the resulting steel was of high carbon content.

As there has since then been more use for low carbon than for high carbon steel, there has been created an incentive to manufacture a richer alloy, containing less carbon relatively to the amount of manganese.

Richer ores were discovered, and alloys of 20 per cent. manganese were manufactured in this country, and this enabled steel suitable for rails and other purposes, with 0.25 per cent. to 0.50 per cent. carbon, to be made.

Still later, especially with the progress of the open-hearth process and the large field opened for the use of mild steel of 0.10 per cent. to 0.20 per cent. carbon, very much richer alloys had to be used.

These were at first made in crucibles, and were very costly, but very soon afterwards they were successfully made in the blast furnace much more cheaply, and are now so manufactured on a large scale and employed universally.

From the successful nature of the manufacture of this alloy, and its use in steel making, other alloys were gradually introduced, and as their properties have become better known, their use has extended, till at the present time their name is legion and their application in steel and iron founding most important.

Until quite recently the only method of producing the ferro-alloys was by means of the blast furnace or the crucible.

Now, however, since the introduction of the electric smelting furnace and its success commercially in the production of rich ferro-alloys, a great variety of them are obtainable at a comparatively moderate price, and some which to-day are of common occurrence were but a short time ago curiosities merely.

The blast furnace alloys are few in number, though very important, and comprise ferro-manganese, spiegel, silicon-spiegel, ferro-silicon, ferro-chrome, and ferro-phosphorus.

The other alloys we shall mention as important to foundrymen are, ferro-aluminium, ferro-titanium, and mixed alloys of the above elements.

The blast furnace products will generally, I think, be the cheaper per ton, or even per unit of the valuable element, than the electrical product, but their chief drawback, especially in the steel works, has been the high percentage of carbon.

In the electrical furnace product this element can be kept remarkably low, whilst, generally speaking, the highest and purest grades can be readily obtained.

It is proposed to consider each alloy separately, and tables of analyses of both kinds of product are appended, showing their composition.

Until recently the importance of the ferro-alloys has been confined more or less completely to the steel works, including steel foundries, but now quite a number of people seem to be experimenting with them in ordinary iron founding, and as they become better known to foundrymen, it is not unreasonable to expect that they may play an important part in the foundry practice of the future.

The manufacture of manganese steel and other special steels of this class has arisen from similar experiments carried out in an intelligent manner in the steel foundry branch, and one need scarcely point out at a meeting held so near to the giant undertaking of Hadfields', what an important result that use of a ferro-alloy has brought about.

Their use in steel works practice is probably well-known to all, and in any case it is not proposed to wander into that branch of the subject unnecessarily. Their use in foundry practice is surrounded by a somewhat different set of circumstances.

The object of their use in the foundry is of two kinds:—

(1) To act as deoxidisers and desulphurisers, the added element remaining only in small quantities in the finished casting.

(2) To alter the composition of the casting and so to gain control of the condition of the carbon and the mechanical properties of the casting.

Ferro-Manganese and Spiegel.

The most important and abundant of the alloys of iron are ferro-manganese and spiegel, the former containing from 40 per cent. to 85 per cent. manganese, and the latter 8 per cent. to 40 per cent. of that element.

The lower grades are very strong and break with large crystal faces of mirror-like polish, hence the name spiegeleisen (German for mirror-iron).

The higher grades lose this characteristic and become soft and friable, having a granular fracture often beautifully stained with rainbow colours due to superficial oxidation.

Analyses of the blast furnace product, as made at one of the oldest works in this line in this country, will be found in Table I., A. and B., and analyses of metallic manganese made electrically in Table III., C.

Any desired percentage of manganese up to 85 per cent. can be obtained in the blast furnace product. The 80 per cent. grade is the one most commonly used, and readily obtainable.

With percentages much higher than this, say, over 82 per cent., considerable difficulty is experienced in storing the alloy as it readily crumbles to powder and oxidises in moist air.

The lower grades, including 80 per cent. are, however, fairly staple, and can be stored like pig-iron, without serious depreciation.

The chief characteristic of this series of alloys is the high percentage of manganese and carbon, which latter, by the way, is all combined.

As the analyses show the carbon rises from 4 per cent. to 7 per cent. as the manganese rises from 10 per cent. to 80 per cent., although relatively to the manganese, there is less carbon in the higher grades.

Some interesting facts relating to the composition of ferro-manganese are given in a paper read before the Staffordshire

Iron and Steel Institute, in 1888, by Mr. Holgate, of Darwen.

One most interesting point relates to the effect of silicon upon total carbon in this metal, particularly the highest grades, the carbon coming down as the silicon goes up to a very marked extent.

Analyses are given in Table II., illustrating this, from which it will be seen how silicon decreases the total carbon.

Much has been said about the value of manganese in cast iron; well, the alloys just mentioned form a very convenient means of regulating this element to any extent desired. The simultaneous addition of a little extra carbon will not be so serious a matter as in the case of steel, but even this could, if wished, be avoided by using the metallic manganese shown in Table III., C.

From the foundryman's point of view, it will always be best to use the rich alloys rather than the lower grades, as by this means the alloy can be added solid to the ladle without unduly cooling it. If the very low grades are used it becomes necessary to melt them either separately prior to addition, or along with the charge.

I believe the latter plan is adopted in making chilled rolls in certain works where manganese is used to influence the chilling properties.

It is a question whether in this case the chill is all that can be desired, as a chill due to manganese is apt to show a sharp line of demarcation between the chilled part and the grey body of the casting, whereas a chill due to carbon alone should extend with roots into the casting.

However, there are people here to-day more competent to judge on this matter than myself.

My own conclusion in regard to the addition of alloys in general to cast iron, is that much greater benefit will be secured by addition after melting, and I shall refer to this later in speaking of ferro-silicon.

In a paper, which I read at last year's Convention, it was pointed out that use could be made of ferro-manganese in the removal of sulphur from common irons, and several instances were quoted in support of the statement.

This, of course, can only occur where the pig-iron is bad to start with, and must not be taken as an unqualified assertion that ferro-manganese added to any iron will improve it. It might do just the reverse in some cases. Excess of manganese hardens cast iron, the limit being about 1.25 to 1.75 per cent.

A considerable reduction in the sulphur contents of iron melted in the air furnace could readily be brought about by additions of ferro-manganese to the molten metal in the furnace, and this without seriously increasing the manganese content of the final casting.

Moreover, at high temperatures manganese is readily oxidisable, and will rob iron of oxygen taken up as oxide in melting, although it is not so efficient in this respect as some of the alloys to be mentioned later. At the temperature of molten steel this property is very strong, but at the lower temperatures of molten cast iron it is less active.

The presence of oxide of iron in cast iron is responsible in many cases for blame put on other things, and the good effects obtained by the use of special alloys are due, in many cases, solely to the removal of this oxygen from the metal.

Ferro-manganese is used by some car wheel makers, where it is thrown as a fine powder (about 1 lb. to 300 lbs.), into the bottom of the ladle before tapping.

It is said that this permits of a much larger proportion of scrap being used along with poorer grades of pig-iron, and that the depth of a chill can be regulated by varying the amount added.

It may, of course, be argued that where additions to pig-iron are necessary in iron foundry practice, they may be obtained at less cost by the purchase of suitable pig-iron rich in the desired element, and no doubt there is something in this, where there is sufficient chemical control to enable it to be carried out.

I am inclined to think, however, that many foundrymen would prefer to retain those mixings with which they have become familiar, and make any alterations they wish by means of an alloy rich in the desired element; the other constituents then remain unaltered, or nearly so.

In any case, it would seem that additions made after melting the iron are most effective, and, after all, that is the point.

Silicon Spiegel.

Closely allied to the foregoing alloy of iron and manganese is a metal containing iron, manganese, and silicon, known as silicon-spiegel or silicide of manganese.

A considerable quantity of this alloy is made in the blast furnace, and analyses of this product are given in Table I., C. Higher percentages of manganese could no doubt be obtained, but with lower silicon contents.

Mr. Holgate, in the paper previously referred to, states that metal with up to 70 or 80 per cent. manganese, and with 6 to 8 per cent. silicon, could no doubt be made in the blast furnace if necessary,

and this alloy would have a very low total carbon content.

The richest blast furnace product on the market will probably contain about 20 per cent. manganese and 14 per cent. silicon; the ordinary commercial article contains 10 per cent. to 12 per cent. silicon.

Richer alloys can be obtained from the electric furnace, and analyses of these are given in Table III., D.

The chief characteristic of silicon-spiegel is the high manganese and silicon together with remarkably low total carbon, and it is interesting to note that when the silicon is under 10 per cent. the carbon is nearly all combined, whilst above 10 per cent. the carbon becomes more and more graphitic, until 16 or 18 per cent. is reached, when it is practically all graphitic; unfortunately the analyses given in Table I., C. do not show this. The electrical products are lower still in carbon.

Silicon-spiegel is used in steel foundry practice to prevent honey-combing, the silicon increasing the solubility of gases in the metal when solidifying, and the manganese removing oxygen from the iron and becoming oxidised itself.

A similar action should take place when the alloy is added to molten cast iron, particularly if melted in an air furnace where higher temperatures can be attained than in the cupola.

The silicon should also have a softening effect on cast iron, which would be still further enhanced by the manganese accompanying it if the iron were previously too high in sulphur.

It seems as though there should be a use for this alloy in the iron foundry, as both manganese and silicon are deoxidisers of considerable power.

Possibly some of our members may have had experience in this direction.

Ferro-Silicon.

Leaving the alloys in which manganese predominates, we come to ferro-silicon, an alloy of iron and silicon, which can be made in the blast furnace up to 20 per cent. silicon, or perhaps a little more. The commercial article contains 10 per cent. to 15 per cent. silicon. Analyses are given in Table I., D.

This alloy is also made in the electric furnace with silicon running up to 95 per cent., and analyses of this and other electrically produced alloys are given in Table III., compiled from published analyses by Messrs. Blackwell, Sons & Company, of Liverpool, who are dealers in, and makers of, these alloys.

Further analyses will also be found in table IV., compiled from analyses made by Mr. G. Watson Gray, F.I.C., of Liverpool, and kindly supplied for the purpose of this paper.

You will here again notice that as the silicon rises from 8 per cent. to 17 per cent., the carbon falls from 1.75 to 0.90, and that in the high grade alloys of Tables III. and IV., practically no carbon is found.

Ferro-silicon has been used very considerably, at least experimentally, in the foundry. Mr. A. E. Outerbridge, in America, has carried out extensive experiments with both ferro-silicon and ferro-manganese, and his published results are very interesting and important.

With ferro-silicon added in the ladle, his results show gains in transverse strength and deflection of as much as 24 per cent. and 30 per cent. respectively, and if this can be obtained regularly it is worth trying for.

Mr. Outerbridge is, however, careful to point out that the silicon is much more effective when added in the ladle than when added in similar quantity to the mixture on the cupola stage, the chief benefit derived from its use being the deoxidisation of the metal by removal of the oxygen taken up from the blast.

There is another very useful feature of silicon, and that is its well-known influence on the carbon content, tending to convert it to the graphitic condition, and so produce a soft casting.

For this purpose there is no doubt silicon can, as a rule, be added to the charge without any additional expense by the use of glazed iron, but one needs to be careful that it is glazed foundry, not glazed forge iron; the latter is high in sulphur, and no good for softening purposes.

This method, however, results in a more or less fixed product, and if the class of work requires considerable variation in the silicon content on the same day, it is at best a clumsy and indeterminate method.

By the addition of ferro-silicon, the silicon content of each ladle can be altered at will to suit the particular castings it is designed for.

Ferro-Chrome.

Coming now to ferro-chrome, we have an alloy which, if it is to be used at all in the foundry, will have to be used very sparingly, and for particular work only, mainly on account of its cost.

The alloy up to 40 or 50 per cent. is made in the blast furnace by using very rich ores, a very large amount of coke

and hot blast of high pressure, but it is very difficult to make on account of the high melting point of the metal and slag.

Analyses showing up to 60 per cent. are given in Turner's metallurgy of iron.

Analyses of the blast furnace product are given in Table I., E., from which you will see that chromium, like manganese, increases the solubility of carbon in iron. The carbon rises from 5.3 per cent. at 13 per cent. of chromium, to 7.12 per cent. at 40 per cent. chromium, and it is all combined.

The alloy can now be obtained from the electrical furnace with up to 70 per cent. chromium, and with very low carbon content, especially after refining. Analyses are given in Table III., A.

Since chromium converts carbon to the combined form, it is a hardener, whilst, generally speaking, in the foundry we are more concerned to find softeners.

Professor Turner, who deals very fully with this alloy in his work on iron, states that ferro-chrome is unsuitable for ordinary foundry purposes.

The writer has, however, lately heard of the use of chromium in the production of castings in which hard wearing properties are extremely desirable, and cost is somewhat secondary, as for example in cast iron piston rings.

Ferro-Phosphorus.

Lastly, we have from the blast furnace an alloy of iron and phosphorus containing up to 20 per cent. phosphorus. Analyses of which are given in Table I., F.

The metal is also made electrically in any percentage desired up to 30 per cent. as per analyses in Table III., E.

Ferro-phosphorus is chiefly used to enrich the phosphorus in the slag from basic steel furnaces, so as to make it a saleable commodity.

The only possible use for such an alloy in the iron foundry would be in the production of very fine and thin castings, artistic work where excellency of detail was of permanent importance and strength secondary.

From 2 to 5 per cent. phosphorus, according to Professor Turner, makes the metal very fluid when molten, and causes it to take an excellent impression of the mould.

Such castings are very brittle, but they have to be made sometimes, and although phosphorus is an element one generally does not expect to have to pay for, but rather to claim something back for, still it may be there is a use for such an alloy in the foundry on work which is only very occasional.

This exhausts the list of blast furnace products, but by no means the list of available alloys, although on account of the scale upon which it is possible to produce, those alloys made in the blast furnace will, as a rule, be less costly.

Of the remainder, those which have been used in the foundry are:—Ferro-titanium, ferro-aluminium, and mixed alloys, such as ferro-aluminium silicide, ferro-calcium silicide, and ferro-manganese aluminium silicide.

An analysis of ferro-titanium is given in Table III., F. It is used in steel manufacture, where it is said to greatly increase the ductility of the steel. It also acts as a deoxidiser at least at the high temperature of molten steel, and in addition titanium combines with nitrogen.

To obtain perfectly sound castings it is important to remove all gases. Consequently an element which combines both with oxygen and nitrogen should be very beneficial in this respect.

It seems probable that combined nitrogen plays a very important part in reducing the strength of cast iron, and if so it will be convenient to have an antidote so handy.

Titanium is said to increase both the transverse strength and the hardness of the chill of cast iron.

Ferro-aluminium, of which approximate analyses are given in Table III., G., is used almost solely as a deoxidiser, and it is very efficient in this *rôle*, but it is undesirable that much of it should remain in the metal.

The chief drawback to the use of aluminium for this purpose is that solid alumina is produced which is apt to remain suspended in the metal, and this causes lack of continuity of the metallic structure and loss of strength sometimes.

There has consequently been a tendency to introduce mixed alloys, and of these little need be said, except that they combine the properties of the other alloys, and in most cases the elements reinforce each other. They are essentially deoxidisers and solvents for gases.

The analysis of ferro-aluminium silicide is I believe the first one to be published. The alloy is very friable and readily crumbles.

Ferro-calcium silicide, of which an analysis is given, is an interesting if unfamiliar product. Its action as a deoxidiser will be very powerful.

Ferro-manganese aluminium silicide is also another of these mixed alloys, which have been successfully introduced in some foundries, and it should be a very useful alloy for foundry purposes.

TABLE I.—*Analyses of Blast Furnace Alloys, made by the Darwen & Mostyn Iron Co.*

A.—Ferro-manganese.

	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Manganese	87.42	84.33	80.62	70.55	61.81	50.50	41.45
Silicon	0.53	0.54	0.30	0.49	0.63	0.14	0.10
Phosphorus	0 155	0.146	0.150	0.199	0 159	0.112	0.095
Carbon	6.31	6 95	7.00	6.68	6.28	6 12	5.62
Sulphur	nil.	nil.	nil.	nil.	nil.	nil.	nil.

B.—Spiegeleisen.

	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Manganese	29.75	22.50	20.11	17.30	14.40	10.72	9 25
Silicon	0.65	0.95	0.42	0.48	0.56	0.45	0.44
Phosphorus	0.090	0.068	0 074	0 065	0.063	0.0 8	0.060
Carbon	5.20	4.89	4.99	4.65	4.32	3 94	3.95
Sulphur	nil.	nil.	nil.	nil.	nil.	nil.	trace.

C.—Silicon Spiegel.

	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Manganese	20.87	20.39	17.50	18 90	20.32	20.50
Silicon	14.23	13.31	12.52	11.80	10.33	9.45
Phosphorus	0.0 8	0.095	0.065	0.081	0.071	0.070
Carbon	1.39	1.51	1.05	1.89	1.26	1.45
Sulphur	nil.	nil.	nil.	nil.	nil.	nil.

D.—Ferro-silicon.

	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Silicon	17.00	13.45	12.42	11.50	10.37	9.25	8.10
Manganese	1.50	1.71	1.17	1.35	1.86	1.86	2.20
Phosphorus	0.0 8	0.058	0.054	0.058	0 060	0.055	0.056
Carbon	0.90	1.21	1.40	1.50	1.51	1.55	1.75
Sulphur	0.04	0.02	0.025	0.030	0.028	0.038	0 045

E.—Ferro-chrome.

	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Chromium	41.39	37.30	34.60	27.71	20.51	13.50
Manganese	1.84	1.95	1.55	1.68	2.73	2.30
Silicon	0.21	0.35	0.36	0 28	0.13	0.14
Phosphorus	0.052	0.068	0.048	0.044	0.065	0·040
Carbon	7.12	6.39	5.52	5.83	5.91	5.34
Sulphur	—	0.022	0.028	0.028	—	0.021

F.—Ferro-phosphorus.

	Per cent.	Per cent.	Per cent.
Phosphorus	20.50	17.85	15.71
Manganese	3.00	2.80	5.90
Silicon	0.500	0.500	0.840
Carbon	0.300	0.310	0.273
Sulphur	0.160	0.325	0.160

TABLE II.—*Showing the effect of Silicon upon Total Carbon in High Grade Ferro-Manganese from paper by Mr. T. E. Holgate, A.R.S.M. Staff. I.S. Inst.*, 1888.

	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Manganese	80.40	80.75	80.80	81.40	79.80	81.00	81.00	80.80
Silicon	0.14	0 28	0.25	0.49	0 60	0.79	1.20	2.10
Carbon	7.20	6.81	6.96	6.74	6.55	6.33	6.20	5.85

TABLE III.—*Analyses of Electrical Furnace Alloys, from analyses supplied by Messrs. Blackwell, Sons & Co., Liverpool.*

A.—Ferro-chrome.

	Per cent.	Per cent.	Per cent.	Refined. Per cent.	Refined. Per cent.
Chromium	66.45	65.35	65.84	69.30	63.59
Manganese	trace.	0.150	0.32	not given.	
Silicon	1.35	1.20	0.63	0.35	0.14
Phosphorus	0.053	0.050	0.02	0.01	0.01
Sulphur	0.045	0.035	0.035	0.040	0.028
Carbon	8 80	7.00	4.72	1.47	0.65

B.—Ferro-silicon.

	Per cent.	Per cent.	Per cent.	Per cent.
Silicon ...	32.70	48.70	75.80	94.80
Aluminium	0.13	0.17	0.08	0.10
Manganese	0.31	0.13	0.11	0.08
Sulphur ...	0.04	0.03	0.02	0.02
Phosphorus	0.05	0.04	0.02	0.01
Carbon ...	0.27	0.0	0.00	0.00

C.—Metallic Manganese.

	Per cent.	Per cent.
Manganese ...	95 to 98	99.00
Iron	2 to 4	1.00
Carbon	under 5	nil.

D.—Silicon Spiegel.

	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Manganese	74.20	73.50	55.00	51.00	38.00
Silicon ...	24.70	24.25	25.00	21.00	21.00
Carbon ...	0.30	0.65	—	—	—
Phosphorus	0.02	0.05	—	—	—
Sulphur ...	0.01	0.007	—	—	—

E.—Ferro-phosphorus.

	Per cent.	Per cent.
Phosphorus ...	24.50	17.5
Silicon	2.47	5.4
Carbon	0.03	0.27
Sulphur ...	0.08	nil.
Manganese ..	0.10	5.75

F.—Ferro-titanium.

	Per cent.
Titanium	53.00
Carbon	3.28
Aluminium ...	0.30
Silicon	1.21
Sulphur	0.03
Phosphorus ...	0.02

G.—Ferro-aluminium.

Aluminium ... 5, 10, and 20 per cent.

TABLE IV.—*Analyses of Electrically Produced Alloys used in Foundries, supplied by Mr. G. Watson Gray, F.I.C., Consulting Chemist of Liverpool.*

	Ferro-silicon.			Ferro-aluminium Silicide.	Ferro-calcium Silicide.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Silicon	33.45	50.40	69.85	45.65	69 80
Iron	66.00	49.06	29.65	44.15	11 15
Manganese ...	0.17	0.11	0.12	trace.	0.22
Aluminium ...	0.11	0.08	0.05	9.45	2.55
Calcium	nil.	nil.	nil.	nil.	15.05
Magnesium ...	nil.	nil.	nil.	nil.	0 26
Carbon	0.07	0.12	0.33	0.55	1.14
Sulphur	0.006	0.005	0.008	0.010	0.014
Phosphorus ...	nil.	nil.	0.036	0.027	0.036
Copper	nil.	0.028	0.034	trace.	trace.

In conclusion, I trust I may have been able to interest you in this subject, and that you will find some food for thought if not for action in what has been said.

The PRESIDENT: Mr. Houghton's paper is an extremely useful one, and very suggestive. It appears to be packed with valuable information, which to the ordinary foundryman is not usually very accessible. I hope you will fairly discuss this paper, as a good deal of alloy work will be done in future.

MR. R. MASON (Birmingham): I don't rise to discuss the paper, but we do know that alloys are coming into use, and will be used more than ever. I have used pure manganese for some time, and I have done well enough when the manganese in casting has been under 0.5 per cent. Recently I tried to raise the amount a bit higher, something over 0.6, and I have since had some trouble with the castings. We get small hollow marks in the castings through which water leaks. I find there is a deposit of some brown material something like oxide of iron. When broken first it is of a dark chocolate colour, and after exposure to the air turns very brown, like ordinary rust. It has happened only recently, and I have had no time to examine it very carefully or to ask anybody's opinion on it. I would be glad to know what that brown powder is. My castings are three-sixteenths of an inch, and the trouble arises at the junction where the castings alter from three-sixteenths to one half an inch, and I always find it at that point. The proportion where the trouble arises is practically 0.62.

PROFESSOR TURNER: You will all agree we have had a very suggestive paper from Mr. Houghton dealing with the properties and production of these ferro-alloys. Mr. Houghton referred to the blast furnace methods, and the electrical methods of preparing these alloys. Another method used to an increasing extent is the pearlite process for the production of vanadium alloys, and titanium. The former is used by steel makers, and the other by ironfounders. With reference to the addition of alloys, the steel maker and the ironfounder are in different positions, because the steel maker must make the addition to his metal before he casts, and so he is in the habit of making it. The ironfounder, as a rule, does not use any alloy, and very often analyses are not made. It is the exception rather than the rule that any analysis should be made, and so there is more danger in the ironfounder going astray in the use of his alloys.

Besides that, the ironfounder in a great many cases can get the necessary composition by a suitable mixture of iron in the first place without any addition. No doubt that is the proper way to proceed when it can be done. It is much preferable to have a standard kind or brand of iron of known composition and to melt a couple together to get the right composition without putting in medicine afterwards. (Applause.) At the same time

special materials are sometimes required, and sometimes we cannot get exactly what we desire in the brands of iron supplied. These alloys ought to be regarded as medicine by the ironfounder, who should keep a medicine chest—(laughter)— and who ought to know what the properties of his medicine are that he employs. There are some people who are never happy unless they are taking pills—(laughter)—but the healthiest man, as a rule, is a man who takes the least medicine, and so with the foundry. The best foundry is where there are the least additions.

But I don't wish to decry, or underestimate the value of these additions when required. We know the immense importance of a suitable remedy; and in connection with the elements used in cast iron, although I have studied the effect of a good many of them, I do not know a single element which has not a beneficial effect upon cast iron in some suitable proportion, or under some circumstances. No element, not even sulphur, can be regarded as an enemy always. Suppose you want a chilled or strong roll, you can't get it unless you have a certain proportion of sulphur or some hardening element. And so it becomes a question of the suitable proportion, and in some elements the suitable proportion is very low, while in others it is relatively high.

We have several elements, manganese especially, that in several instances are being used. It was introduced in recent times by an American, and it is used by the majority of car wheel builders in America as an addition in the ladle to their castings. Apparently, it helps to give the right quantity of chill and the right backing to the chill. The reason is that the original material did not contain quite the right quantity of manganese. About twenty years ago I calculated a very large number of tests, particularly those from Woolwich Arsenal, and I came to the conclusion that it could not be shown that manganese produced any effect up to 1½ per cent., while beyond that it was a doubtful quantity.

Silicon also has been applied by Mr. Outerbridge for other purposes in the form of high silicon added to the ladle before casting. That is a new idea, because it was not known before 1867. It was in France that it was pretty widely applied, but at that time it was given up because ferro-silicon was so much more expensive than ordinary silicon, and that is the reason why manganese, which has such a beneficial effect upon the surface, is more extensively used.

With regard to what Mr. Mason has said, I should suggest that these brown stains are manganese sulphide. It can only be determined by microscopic examination or chemical analysis, and the reason why silicon acts even when you have not enough for ordinary purposes is that at the last moment it throws out a small quantity of carbon in a finely divided state as secondary graphite or temper carbon. Apparently, the mechanical properties of iron are dependent upon the separation of a small amount of temper graphite during the process of elimination.

Other alloys have been used for turning white iron into grey, or making strong iron soft. The difficulty met with in practice, or one of them, is that if you have much aluminium present it causes a fine skin over the metal which does not run to the end of the thin part, whereas in melting we require the metal to come right to the end. What little is left in the metal is so extremely small that sometimes you don't get any at all, while sometimes you get too much, owing to a little difference in oxygen. That is the chief reason why aluminium has not been kept up by a number of people who started it, namely, because it produces such an irregular result. If you could ensure getting 0.04 present of aluminium, it would be a good thing, but you can't; sometimes it is too much, and sometimes not enough.

The writer did not refer to nickel in the iron foundry. It is used for some purposes to about the extent of 1½ per cent. where a close grain and a soft condition of metal are required. I have had some samples of nickel cast, and the result is simply excellent. On the other hand, it is a somewhat expensive material.

We have heard a good deal of the use of titanium as a special alloy to the improvement of irons in this country. I have met with irons with 0.08, and they have sometimes as much as a quarter per cent. in the metal, but I never knew any ill-effects produced by titanium, and I never knew, of all the samples submitted to me, one that was found defective. This is an important question for the iron makers of the world, because although we don't use metallic ores in large quantities, the proportion of metallic iron that exists is enormous. There are whole mountain ranges of ores that are not used on account of titanium. There are two reasons, the first is the difficulty of smelting. I am told that can be got over by a simple composition of slag—that is a slag which has not got too much

silicon. There are a number of results published within the last few years, particularly by Rosse, in the United States, and you would do well to see an article in "Cassiers Magazine," an illustrated article giving full details of titanium. I must say I have great hopes of the future of titanic ores, because I believe when we know better how to smelt them, in that they are generally very low in phosphorus and very high in iron, by a suitable mixture we shall have yet of the best foundry irons that can be got, a good strong grey iron.

In Germany they are dealt with in electric furnaces, but in England they are scarcely known.

Another matter relates to the removal of nitrate. We can sometimes see the little crystal called cyanide of nitrate in the residue. What the influence of nitrogen is in cast iron, we at present scarcely know, and it is extremely doubtful. Some people think that nitrogen is deleterious. The Swedish authorities, who are generally careful in regard to facts, attribute the effect shown in the crystals to the removal of nitrogen. We have had silicon and calcium of iron dealt with together with 11 per cent. of iron, and that must be made in an electric furnace. Calcium is a metal now to be obtained commercially. It is a very light metal, very strongly desulphurising in its effect, and it can be bought at 6s. to 7s. per lb. Some authorities state that iron and calcium do not alloy. But you can get iron and calcium, and the question is how much calcium you can put in a simple pure iron. We know that in the blast furnace no calcium goes into the iron, and it would have to be used very carefully in an ordinary blast furnace. If you could get calcium in, that would mean the removal of sulphur. If there is any possibility it may be a question of the future, and the possibility may open up great development. (Applause.)

Mr. Mather (Middlesbrough): The most interesting to me were the remarks made about the oxidising effects of silicon on cupola metal. If, as more silicon is used, there is any appreciable quantity of iron oxide left in the molten metal it is likely to have very serious effects on the properties of the metal. One would expect that silicon would have an effect in removing this oxide, and therefore the effect would be beneficial on the properties. I have not previously come across any records of the occurrence of oxide of iron in cupola metal to any considerable extent, and I should be glad to know whether it has been identified chemically or microscopically, or by any other means showing that there is oxide of iron present to any extent in the cupola, and if so, if it is an occurrence that can be prevented by adding more silicon to the iron melted, or whether we can remove it by the addition of silicon in the metal. Pure metallic chromium practically without any impurity can be obtained now on commercial terms, and so with manganese. This has been used to a considerable extent with over 99 per cent. of manganese. For any purpose for which manganese is wanted to go with other metal, such metal is very useful.

Mr. R. Buchanan (Walsall): The last speaker has expressed what has been in my mind, namely, that the fact or otherwise of oxygen being present in the metal has yet to be proved. I know that from experience of scientific blast furnacemen who decline to admit or to believe that with ordinary grey iron having 2½ per cent. to 3 per cent. of silicon you can have oxide existing alongside such an amount of silicon and with the silicon in the metallic condition; and so before we can say what is the exact function of the addition of these metals, such as manganese, or as to the claim that they eliminate oxide, we have got first of all to prove that it is present for removal. It may have been proved, but not so far as I know. Certainly direct positive proofs still remain to be got.

Mr. Houghton spoke about mixing metals in the cupola or doctoring them afterwards by additions, and Professor Turner has taken the common-sense and business-like view that your mixing ought to be done in the cupola. Mr. Houghton saw the necessity of having obtained scientific and chemical control of the alloys. Now a man who has a knowledge of his metals is the only man who can safely use materials with which to doctor his iron. If a man is competent to judge when to use, and when to abstain from using these special alloys, such a one is almost certainly quite competent to mix in the cupola. To put special alloys into the hands of a man who does not know the exact constitution of the iron that he is melting, is to offer him 99 chances out of a 100 to go wrong. He is going to play with edged tools, and he is certain to cut himself. (Applause.) Until he knows what to produce, and how to produce in the cupola, I would say leave the doctoring alone. (Applause.) The man who does not know how to mix the metals in his cupola scientifically had better stick to the old brands and trust to them without trying to doctor them.

If anyone cares to mix his own ferro-aluminium I don't mind telling him what was told to me by a man who mixed many a ton of aluminium, and gave me the tip. I never tried it myself, but no doubt it is quite likely to work. You get your ladle, and suppose you want to mix 10 per cent. of aluminium in your iron, you put in your ladle 90 lbs. of iron, first taking the tare. You place your 90 lbs. of iron in the ladle on the scales, and you add a small bit of aluminium at a time, stirring it. You ask me, "Why not put it in all at once?" The thermetic process shows that there is a tremendous reaction between aluminium and iron, and you can burn your oxides, or otherwise destroy them by over-heating through the reaction which takes place between the aluminium and the iron. You add a little aluminium and you wait until it gets a lower temperature, and when you stir more in the temperature rises, and so you wait until you are able to put in a little more. The point is to add a little at a time until you get it cooled down, and then you get it thoroughly stirred, and you get it in suitable form for working. Anyone who wishes to make his own can do so in that way.

The PRESIDENT: I should have been inclined fo agree with the statement in regard to no oxygen being present in pig-iron; but that does not tell us that there is no oxygen present in castings. I may remind foundrymen that if you melt scrap you will be sure to find some oxygen in the castings. Another point is the point of cupola mixing. I have very little faith in the mixing in cupolas of extreme irons or irons extremely different in composition. The result is very indifferent unless you make use of a very large ladle. Unless you mix irons very similar in composition the result is unsatisfactory. It is a common practice to put in different irons and expect to get the right result for different kinds of work.

MR. HOUGHTON, replying, said: I have to thank you for the kind way in which you listened to my paper, and the kind remarks that have been made. With regard to Mr. Mason's difficulty when he got over 5 per cent. of alloy, I imagine that in increasing the quantity he had got the metal clotted together, and so formed manganese oxide, or it might be manganese sulphide. I listened with considerable interest to Professor Turner, who gave us a short paper on the subject himself. (Applause.) A variety of work has been done by Swedish chemists in regard to nitrogen cast iron, and I have done some little myself on our own irons, but not enough to give any result to this meeting. I am inclined to think that nitrogen has some considerable effect on the properties of cast iron, and if titanium would remove it, it would be convenient to have an antidote so handy. With regard to the remarks as to the presence of oxide of iron in cast iron, Mr. Outerbridge in his paper speaks as having satisfied himself as to oxide of iron being present. But as Mr. Pilkington said, when we know scrap iron is melted down in the cupola and contains oxygen, it is likely there may be some in the casting. Then again, I have noticed iron made in a cupola show a dark slag which indicates oxidising conditions. I attribute it to the presence of some oxide of iron.

As to the remarks about the manufacture of ferro-aluminium, I can believe what was said as to the stirring. The way we make ferro-aluminium is to do a little at once. We tried to make an aluminium manganese alloy direct from the blast furnace, and we had a deal of difficulty with it. We tried running from the blast furnace over small ingots of aluminium, and the best we could say was it was not a success. It was not possible to do it in that way. Eventually some modification of the method, such as Mr. Buchanan outlined, was finally adopted, and we got the desired composition. If any thought strikes anyone else I should be glad to answer it in private conversation.

MR. SHERBURN: I should like to ask Mr. Houghton has he found in practice that he can get higher temperatures in an air furnace than in a cupola?

MR. HOUGHTON: I have had no experience with an air furnace at all. But it is pretty generally allowed that metal from an air furnace in steel practice is considerably hotter than the metal from a cupola.

The PRESIDENT: You will all agree to thank Mr. Houghton for his paper. (Applause.)

MR. E. L. RHEAD, lecturer on metallurgy, Manchester School of Technology, next read his paper on:—

"THE CHANGES IN CAST IRON DURING AND AFTER SOLIDIFICATION."

The production of strong, sound castings is the aim and object of the founder. For commercial purposes they must be produced as cheaply as possible.

Few industries present greater difficulties to the successful attainment of the object in view. The conditions are of such a widely varying character, and the control of them so difficult even when properly appreciated, that even with all the

available knowledge at command, it is not certain that success will in all cases be assured.

In the days of the older ironfounders the causes of the trouble were but little known and all sorts of conceivable and inconceivable reasons were assigned as the causes of failure.

Chemical and physical science were in their infancy, and attention was turned to fields of investigation more inviting and fanciful than such matter-of-fact and dirty operations as are associated with foundry practice.

Scientists and professors seldom displayed any particular interest in matters bearing on the manufacture of such commonplace articles as pots and kettles, and most of the information they had was obtained at second-hand, and with the interpretation on it of the man who had witnessed the operations and phenomena. Small wonder that under such circumstances founders grew up to rule-of-thumb methods of working. They observed for example, that irons from certain districts or of special appearance produced satisfactory results, and that particular methods of procedure improved the character of the castings.

Arguing logically (at any rate from the data in their possession) that similar treatment would benefit similar castings from different irons in the same way, such treatment was followed till experiment proved the contrary. Such experiments are costly, and the adage that "experience is a dear school," was too often proved. "Let well alone," is the maxim of all men who, without knowledge, proceed on rule-of-thumb methods in commercial work and in the selection of iron, and a method that will yield the result desired is adhered to by them so long as satisfaction is obtained. So particular irons were credited with special properties and gradually became recognised as the most suitable for a given purpose. This preference was reflected by the estimation in which they were held, and the prices they commanded. The fact that from time to time failures resulted had to be explained away and remedies devised. Some of these were, without the lines on which they operated being known, effective, and gradually practice was built up until the founder developed into a skilled craftsman of the highest order, and his self-reliance led him to scout interference from outside. Still, failures were many, and progress slow. Prices were affected; payments for the good must cover the losses on the bad castings, and hence all trades using iron castings were adversely affected, and their progress retarded. Entering as such castings do, so largely into the requirements of modern life, this retardation was necessarily marked.

Now, this is to a great extent all changed. Systematic investigation has taken the place of indiscriminate experimenting, and little by little the conditions governing successful foundry practice have been in a large measure made clear.

From the results obtained it has been established that success or failure depends almost entirely on the metal used, and the treatment to which it is subjected in the melting and handling, in the moulds, and after removal from the sand, the effect of the treatment being determined by the chemical composition of the metal. So much has been established, but the precise part played by each constituent, and how the presence of another constituent may modify the result is not at present completely cleared up. Synthetic methods, that is by adding the separate substance to iron, are the only ones by which this can be effected, and with a large number of variables it becomes possible to form an almost infinite series containing the ingredients in varying proportions, thus making the task a long one.

I have mentioned these points at the outset, because so many ironfounders still regard all scientific applications as so much rubbish, and pooh-pooh the idea of improvement from such a source.

The behaviour of metal during the process of cooling from fusion is practically, as stated above, the principal point to be borne in mind. How it cools, and whether evenly or at different rates in different parts, will depend on the mould into which it is run.

All the difficulties of shrinkage and the unsoundness and sponginess it causes, all the internal strains producing incipient weakness which may on slight provocation develop into fracture, all the changes in structure and appearance, the crystalline, mottled or dull fracture, the close or open character of the metal, in fact, the hundred and one variations possible are the result of changes which take place naturally, or are modified by design or accident while the metal is fused or in a heated condition.

Molten matters cooling from fusion have a tendency to assume a crystalline form as they solidify.

This property is due to some inherent principle resident in the ultimate particles (molecules or what you will), of which the substance is composed, and is as much a characteristic of the body as any other

property. Whether it can manifest itself and the exact manner in which it is manifested will depend on circumstances, but under the same circumstances it will be exhibited in the same way and in the same degree. Since a crystal is an aggregate of small particles of the same kind, but arranged in a peculiar manner, it is clear that any particle in the crystal is capable of occupying any position in the structure of which it forms a part, and that the form developed will be dependent on the peculiarities of the substance. (At this point a number of crystal models were exhibited.)

In some, similar influences operate equally in each of three directions at right angles to each other and cubic forms result.

In others the action is greater in one or other direction and a different development takes place.

The properties of the crystallised substance differ from those of the amorphous bodies of the same composition, in density, hardness, expansibility by heat, etc., and the same body differently crystallised has special properties in each of its forms.

Further, all parts of the same crystal do not possess the same properties. Some parts are harder than others (*e.g.*, edge of diamond), and in different directions the effect upon light in transparent bodies.

The nature of the electrification and the expansion by heat and the extent to which they are affected by chemical agents, differ in different directions, always having a definite relation to the shape of the crystal.

These differences are due to the manner in which the particles are arranged with regard to each other. To use a simple though probably not an absolutely correct simile, the bonding in brickwork determines its strength rigidity and other characters, as well as do the materials of which it is built up. So, a crystal may be made of material which arranged in one way is soft, and in another very hard, and as it is easier to dislodge some bricks from a structure than to dislodge others, so one part of a crystal may be harder than another because of the greater cohesion existing between the bricks.

Now, I think it will be clear, 1st that crystal bodies have destructive properties not possessed by the substance in its uncrystallised state.

2nd. That different forms are possible.

3rd. That the characters of a crystal may differ in different directions.

But it must be further remembered that to possess crystalline properties does not involve the possession of the crystal form. If the substance has been subjected to those conditions that would produce the crystal, but was so confined that the free movement of the particles was interfered with, and the full development of the form prevented, the product will still possess the properties of the crystalline substance in its perfect form. Perfect crystals are only produced naturally when completely surrounded by fluid. Often this only occurs at one side, sometimes the whole space is surrounded by solid containing walls which interfere.

But the substance and its properties are the same. If a fused body be cooled with sufficient rapidity, no arrangement of particles can occur, and no crystals formed.

With rocks and transparent bodies it is easy to demonstrate the progress of crystallisation and in succession minute grains, hair-like bodies, rods and skeleton crystals are visible in the cooling body.

With opaque bodies like metals, this development is not so easy to show as the examination is confined to the observation of the structure of polished surface and fractures. Sometimes, however, cavities occur in the mass, and these are found lined with crystals, or at any rate, presenting appearances of such a nature that they cannot be mistaken.

Just a word to explain the curious roughnesses which make it so difficult for many people to recognise the crystalline character of such specimens.

You will remember that allusion was made to the fact that any particle entering into the construction of a crystal could occupy any position in the structure, and that the position it assumed was determined by the special conditions that obtained at the moment. It follows that any particle may, instead of falling into line with the others, become the nucleus for the commencement of another crystal growing in a direction not comfortable to that already in existence. Such a procedure would produce first a roughness on the crystal surface, increasing to a projection, and finally a branching arrangement if the deposition of the solid continued to take place over the combined surfaces.

In the present case not only has this occurred, but the parallel ridges that are observed encircling the crystal are the edges of simple octahedra (model shown) piled one on another in such fashion that only the edge of each remains as independent.

Bear in mind the crystal has grown in this manner, and parts of one are common to others by interpenetration.

The crystal also shows the manner in which interlocking of the crystals may occur as the crystallisation proceeds, thus giving a strength and rigidity otherwise unattainable.

It will, I believe, interest you to know how this crystal was formed. It occurred in a cavity in an ingot of mild steel.

Leaving out of account for the moment the presence of foreign bodies, let us consider the manner in which the crystallisation progresses.

Probably no statement in connection with the crystallisation of iron is more common than that the crystals arrange themselves at right angles to the cooling surface, and everyone is familiar with the appearance presented by cooled sections of crystalline metals.

In chilled castings such appearances are easily seen, and in ordinary grey castings of a close nature something closely approaching this is often visible on the outer portions.

But the primary form of iron is an octahedron belonging to the cubic system, in which elongation in any particular direction is abnormal.

The growth of the crystal in any particular direction is due to the manner in which the heat contained in the metal is dissipated during the cooling.

When the molten metal entering the cavity of the mould comes into contact with the sides it is cooled, and a crust of solid metal forms. This at first is thin and increases in thickness as heat is lost. The inner surface is not smooth, but roughened by the tendency to crystallise. How far actual crystallisation can proceed will depend on the cooling rate, but in all cases some attempt at crystallisation will occur. Once an irregular surface is produced inside the cavity, the solid portions will offer a more ready transmission of heat from the interior, and consequently the ends become the points to which the solid material separated by cooling will become attached. In this way they become elongated in a direction at right angles to the surface to which the heat is finally conducted for dissipation.

This action of the roughnesses or crystallites arises partly from the higher conductivity of the solid, but more largely from the fact that having solidified it has lost its latent heat, while the fluid lying between and beyond has to cool to its solidifying temperature, and in changing its state to further lose its latent heat the latter retarding its solidification, and while it cannot cause fusion of the parts already solid since it is only at the fusion temperature the heat must be conducted away before solidification can occur.

It will be seen from the above that it is immaterial what form the body assumes in perfect idiomorphic crystals, when cooled under conditions far removed from its melting point, as iron is; the arrangement at right angles to which reference has been made, is bound to occur.

An excellent example of crystals forming in this way is afforded by sulphur, but this example, although often cited, is not on all fours with iron. In this case the natural form is a long, needle shaped, idiomorphic (perfectly formed) crystal; but the extension of such through the molten mass, while surrounded and washed by the portion still liquid, and the interlacing formation they assume is most instructive. The melting point of the S. is not high, 115 degrees, and the specimen under consideration was slowly cooled.

From the above it would appear well shaped crystals of bodies having high melting points can only be obtained by slow cooling, and this is well shown by the brittleness and crystalline fracture of metals so treated. It is possible to cool fused bodies below their solidifying point, with solidification taking place. This state is known as surfusion.

This involves the substance so cooled being kept quite still. Any agitation leads to solidification if the temperature has been so reduced that the latent heat (given out during solidification) is not capable of raising the body above its melting point; the solidification will then be instantaneous and complete. If it be capable of so doing, then a portion will solidify and the remainder by cooling in the ordinary way. In such a case as the latter crystals shoot throughout the mass simultaneously until the mean temperature is raised to the melting point, and the cooling of the enclosed liquid goes on in the normal manner.

Possibly the enclosed liquid again cools to surfusion, as the crystals that already exist envelope, enclose and retard the movement of the still fluid mass.

Hitherto, we have considered only the cooling of a simple body or rather have considered cast iron as only a simple body.

Its complete character is known to you. The ultimate constituents, carbon silica, manganese, phosphorus, and sulphur are familiar, at any rate, in name. Do not, however, think of them as existing in iron in the simple form.

The silicon is there in combination with iron and manganese, and possibly with other elements; the carbon in molten

pig-iron is in combination with iron and manganese as carbides of those metals, and also in the free state as graphite, and as temper graphite; in the solid, the sulphur exists as sulphides of manganese and iron, and the phosphorus as phosphide of iron.

Just now I am not concerned with the special combinations of these elements, but only wish to draw your attention to the very highly complicated character of the metal in view of the possible combination.

It must be remembered that whatever the state these bodies assume when the iron is solid, in the molten condition thereof they are combined with others, and all the compounds are dissolved in the iron which forms the bulk of the metal. If not dissolved they would separate in layers in virtue of their different specific gravities.

We are therefore concerned to know what happens when such a mixture of fused bodies solidifies.

The amount of a substance that can be dissolved and held in a solution by a liquid is generally affected by the temperature. This obtains in ordinary cases of solution in water.

Thus at 0 degrees C. water only dissolves a little over $\frac{1}{3}$ of its weight of potassium nitrate; at 100 degrees it dissolves nearly $2\frac{1}{2}$ times its own weight, nearly 20 times as much.

There are a few exceptions to this general rule, but only a few.

If a hot saturated solution of nitre be cooled, crystals of nitre are deposited in greater amount as the cooling progresses, leaving always a solution saturated at the temperature to which it has fallen. These sink to the bottom or attach themselves to the sides of the vessel or to rods or other supports suspended in the liquid.

In crystallising from solution the most perfect crystals are produced slowly.

When crystals of a substance form the impurities are rejected and remain in the liquor if more soluble, or if the solution be not saturated with them.

This separation may not take place with sufficient freedom to secure exclusion. Some enclosures may take place and produce parallel markings.

Further, the presence of a dissolved body lowers the freezing point of the solvent. If a saturated solution be gradually cooled, separation of the solid occurs as the temperature falls till a certain low temperature is attained, when the remainder solidifies (solid and solvent) together in the proportions in which they exist in the solution. This low temperature is below the solidifying point of even the solvent.

A solution of salt in water is a good example. If the liquid be saturated, salt is thrown down as the liquid cools, and this continues till 22.5 C. before solidifying. With a weak solution the freezing point falls below 0 degrees before ice is formed. This ice is practically pure leaving the solution more concentrated.

If, say, a solution containing five parts per 100 be used, the temperature falls to 3 degrees before ice separates, and the solution becomes more concentrated. As cooling goes on more and more, ice separates, and concentration increases till —22.5 degrees C. is reached, when ice and salt deposit in definite properties containing 23.8 of salt. These are not combined. The water (ice) can be dissolved out by alcohol, leaving a salt skeleton. During the solidification they separate side by side in microscopic contact. The temperature will not fall below 22.5 till the whole has solidified.

Similar separation takes place in cooling iron.

The solubility of bodies is affected by the presence of others, and it is possible to cause a substance to be precipitated by the introduction of another soluble body. Thus the introduction of salt into a soap solution causes the separation of the soap.

During cooling some substances separate and are thrown to outside of grains.

Remembering these facts, and also the complex character of cast iron, the intricacy and difficulty of tracing the possible changes in iron will be apparent, since both the relative amounts and the solubility of the substance present in the iron will affect the result.

Recent investigation has shown the continuity of the liquid and solid states, and the possibility of changes taking place in the solid that were formerly only thought possible in the liquid state.

So it happens that carbon separates as graphite during the cooling of iron, especially in the presence of silicon, the size of the graphite depending largely on the rate of cooling and the amount of silicide present. The effect of the latter in causing the precipitation of graphite to commence early in the cooling of the iron increases the amount of the graphite and the size of the flakes and the greyness of the iron.

In the cooling of metallic mixtures and solutions something very analogous takes place. With the falling temperature the constituents separate iron more or less pure as a solvent or substance in solution whose solubility is diminishing. The effect

is, as in the case of the salt solution, to produce by concentration a fluid residue having the lowest melting point at which the solidification takes place, and solvent and dissolved body separate together in the ratios in which they exist in the solution. Crystallisation of a complete character is impossible since this can only occur when perfect freedom of movement or very prolonged opportunity under restriction is possible. The nearest approach that can be attained is an attempt at arrangement which produces either a rod-like structure, similar to the skeleton rod, or a platy arrangement, more or less distinct, the least distinct being points.

This structure is called the eutectic structure, and is met with in all cases where incipient separation occurs during solidification. The perfectness with which it is developed depends on the time occupied during the solidification of the eutectic itself, as the latent heat of solidification has to be removed. As the completeness of the concentration depends on slow cooling, allowing the dissolved body to be extruded from the forming crystal, it follows that all conditions retarding cooling tend to favour the perfect development of the structure. In castings, mass, temperature of metal, and cooling conditions affect this, and hence the structure. The arrangement of the included matter will depend on the conditions under which separation occurs.

With various substances present it is possible to have different solidifying points for different solutions, and eutectic structure may result from each. Silico carbon ferrite and phosphoric eutectic silico ferrites change during the solidification of phosphoric eutectic by the heat evolved, and the change is prolonged and any possible separation of the constituents that may be taking place is made more complete.

When crystals separate from solution the more soluble impurities remain in the mother liquor. Substances not more soluble and separating may be entangled, and form zone bands in crystal something like the eutectic.

How all this affects the practical questions involved in the making of castings will, on reflection, be apparent.

Iron, which forms the principal constituent of the molten metal, contracts on solidification, and even when crystallised is denser at its solidifying point in the solid state than when molten. Substances that are naturally less dense when in a separate condition are, when included in the crystallising iron, I believe, prevented from assuming their normal characters, and their density and other physical properties are more or less impressed and modified with, and by those of the substance in which they are dissolved, and the effect is mutual. Consequently carbide of iron remaining in solution does not prevent this contraction, and cast iron containing most combined carbon contracts most strongly, as for example white iron castings. In this case also the pasty stage so noted may be due to the solidification of the eutectic occupying a longer period, the carbide remaining dissolved in the iron. If, however, the carbon be precipitated during the progress of the solidification, the separated graphite will be less dense, and will occupy a greater space, so that as the metal cools and contracts this internal increase in volume compensates for the contraction, and may actually exceed that contraction of the iron that occurs at the moment of solidification, thus explaining the expansion and the fact of the metal being lighter in the solid than in the fluid state.

This separation progresses throughout the cooling mass, and may be completed when the heat is prolonged. It continues after solidification has commenced, as Keep has shown, the amount of combined carbon becoming less during the cooling.

Further, the precipitation of the carbon by the silicon explains why carburised siliceous irons make the soundest and strongest castings.

That this separation is progressive, and may be aided or retarded, is made evident by the changes occurring in the manufacture of annealed or malleable castings, and in the softening of ordinary grey castings for turning purposes. The more or less prolonged heating which such castings undergo produces the separation of the carbon as temper graphite, and in ore annealed ultimately effects its removal. The castings under this treatment expand permanently, and an increase varying from $\frac{1}{32}$ to $\frac{1}{8}$ in. per foot, and in a few cases personally observed somewhat more takes place.

This heating has permitted the completion to take place of a change that would have occurred in the original cooling down if the time of cooling had been prolonged.

You will also be acquainted with the fact that in ordinary castings heavy ones contract less than light ones. This is partly due to the slower cooling of the greater mass.

Closely connected with the crystallization and the principles regulating it is the formation of cavities in castings. As the metal solidifies it attaches itself to the faces of the already existing crystals, and consequently is drawn towards the cooling

parts. These crystals are extending inwards and projecting into the molten material. The portions behind included between the primary crystals solidify, and the mass behind contracts by loss of heat after becoming solid. So long as channels exist between the crystals, by which the metal can move down to supply the deficiency, metal will be drawn from the fluid interior, but so long as it remains in contact with the crystal, it will continue to deposit fresh layers on their sides.

This withdrawal of metal accounts for the shrinkage holes, and traces of crystals can generally be found on the face of such cavities. Generally such holes are rough on the interior, and generally grey in colour. Sometimes they are coloured by oxidation of the surface. The hole formed in this way is vacuous, and gases from the metal or steam drawn through porous places may enter the cavity, if a large one, while the metal is still hot enough to decompose it and a coloured film is produced.

Sometimes these holes are put down to the liberation of gas from the metal of the casting. Such an explanation is only half a truth. They may be filled with such gases, but the hole into which the gases pass was originally formed during the solidification.

Any condition that tends to keep the metal hot locally has the same effect of causing cavities of this nature, and the great advantages often derived by splitting up gates so as to run at several points, is due to the more equal distribution of the heat. Run with one gate all the hot metal would have to pass a certain part of the mould, make it very much hotter and slow down the cooling. Run with several gates local heating of the mould is prevented, and the cooling is more regular. Pouring temperature and all other causes tending to vary cooling rates will have their due effect, all in the direction indicated.

The weakness and cracking of plates and other castings during final cooling is due to weakening caused by the drawing away of the metal from these parts that crack, generally the centre and intersecting lines in the angles of the casting in each of two directions due to the solidification of metal between the crystals.

There is one other phenomena connected with solidification that must be noticed. It is possible to cool down a solution to a point below that at which it should crystallise or solidify, without any separation of solid matter taking place with ordinary solids dissolved in a solvent; this is known as super-saturation of the liquid with fused mixtures as surfusion.

In ordinary cases, absolute stillness of the cooling liquid is necessary. Agitation or the introduction of a crystal of the solid will cause it to solidify at once. In a cooling casting of large size all the conditions suitable for such absolute stillness are found Every result of the cooling tends to envelop and retard the movement of the fluid so that when it finally solidifies any change of volume, whether an increase or a decrease, or any heat evolution due to latent heat evolved occurs suddenly. Increase in volume or evolved heat will tend to arrest the contraction, or may produce actual enlargement, any contraction to the production of stresses or actual strains, or sponginess and unsoundness in the interior.

The PRESIDENT: Mr. Rhead's paper has been exceedingly interesting, but it will not be possible now to discuss it. There is no shortage of material for discussion, but the paper will be printed, and therefore you will be able to read it, and anybody who wishes to make remarks can send communication in writing. You will agree in thanking Mr. Rhead for his paper.

MR. RHEAD: Thank you, gentlemen, but I regret that owing to lack of time it had to be so scrappy.

MR. R. W. KENYON (Manchester): I have to move a resolution, and I will do that briefly. Perhaps we who have the advantage of living in Manchester may be able to get Mr. Rhead to continue this subject for our special benefit. I have to move a vote of thanks to the Governors of the University for the use of the building, the local Committee for making the arrangements, and all those who have helped to promote the success of the Convention. To me it has been a most interesting meeting, and I regret I was not here for the whole of the Convention.

MR. F. HOWE (India): I have much pleasure in seconding the vote of thanks.

The PRESIDENT: You will all agree with this resolution, particularly with regard to the Governors of this University.

The resolution was carried.

This concluded the proceedings.

In the afternoon visits were paid to the steel foundry of Messrs. S. Osborne & Company, Limited, and Cammell, Laird & Company, Limited, the parties being about equally divided.

In the evening a smoking concert took place at the King's Head Hotel, arranged by Mr. W. F. Bagnall, of Sheffield.

Thursday was devoted to a drive to Chatsworth, Haddon Hall, and Bakewell, in which nearly all the members took part. This social event concluded the annual meeting.

JUDGING COKE FROM ITS APPEARANCE.*

By A. Thau, Clay Cross.

Though chemical analysis forms the proper basis for judging coke, and though it cannot be judged from its appearance in the same manner as an expert founder, for instance, knows how to almost exactly value iron and steel from the appearance of the fracture, the appearance of coke when examined carefully is in many respects a guide in judging its quality.

Fig. 1.—Beehive coke (left hand) and ordinary coke (right hand) from the same coal of the Clay Cross Company, Chesterfield.

For the manager of the coke works a careful examination of the coke is important, because thereby he can recognise not only the quality of the coke, but also the working of the ovens and the nature of the coal coked. For the coke user, however, the possibility of approximately determining the quality of coke from its appearance will be most important—firstly, if no chemical laboratory is available, and, secondly, because it is difficult, if not impossible, to take a reliable average sample from a great quantity of coke.

Generally, comparatively little attention has been paid to the thorough examination of the appearance of coke, which may be accounted for by the fact that even the opinions of old expert users on the appearance of coke widely differ. While one considers very dense coke the best, another one prefers the porous article. But all agree that coke should have a colour as light as possible in silver grey, that it should not be too hard, and that it should be in as large pieces as possible. As to the quality according to the analysis, the principal consumers—blast furnace and foundry—require a coke containing, if possible, below 1 per cent. of sulphur, no more than 10 per cent. of ash, and not above 1 per cent. of volatile matters, the amount of water generally not to exceed 6 per cent.

Fig. 2.—Beehive coke (left hand) beside ordinary coke (right hand).

Analyses.

Beehive.	Ordinary.
10 per cent. ash;	11.2 per cent. ash.
1.511 per cent. sulphur;	1.531 per cent. sulphur.
1.00 per cent. volatile matters.	0.99 per cent. volatile matters.

Unfortunately, the appearance of the

* From the 'Iron and Coal Trades Review."

coke offers no help for the determination of sulphur, and this complicated analysis is reserved for the analytical chemist. An approximately correct opinion, however, can, after some practice, be obtained as to the percentage of ash, volatile matters, and water. Further, one can distinguish if the coked coal was compressed or loosely charged, if the oven had the right temperature, and what sort of oven it was. In order to illustrate and explain the exterior characteristics, several pieces showing special marks so plainly that they can be recognised, are reproduced, described, and analysed herewith.

On the Continent, apart from the gas coke produced in gas works, there is only the question of the coke yielded by coke ovens with horizontal axes, whereas in England the production of beehive coke prevails. The latter is in quality superior to Westphalian coke, as, according to the filling and burning of the beehive oven, the pieces may reach a length of above 20 in., and also because it is partly quenched in the oven, nearly all the water evaporating. The beehive oven has a flat hearth in which the process of coking begins most strongly from below so that the coke stands upright. Fig. 1 shows a medium-sized piece of beehive coke; beside it, in order to indicate the size, being placed a piece of patent oven coke, both from the same coal. The beehive coke can easily be distinguished from the other. Apart from the long-stalked shape of the pieces, it is without the metallic sound peculiar to other coke. It has a beautiful silvery gloss; all the small unevenness of the surfaces is rounded off so that the pieces are quite smooth and oily to the touch. Figs. 1 and 2 show two pieces each made from the same coal of the Clay Cross Company, Chesterfield. The lighter piece, in Fig. 2, is beehive coke. The percentage of ash in beehive coke is mostly somewhat higher than in others. Though nowadays there are still works in England sticking persistently to beehive coke, in spite of its higher cost, so that its production is greater than that of patent oven coke, still the time is not far distant when beehive ovens will be completely superseded by the large number of projected patent ovens, and those already being built.

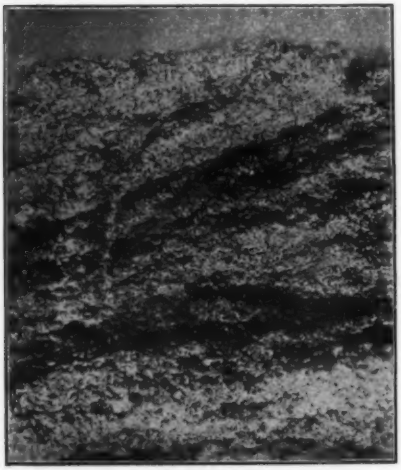

FIG. 3.—RHENISH-WESTPHALIAN COKE FROM COMPRESSED COAL.

Analysis.—6.1 per cent. ash; 0.926 per cent. sulphur; 0.81 per cent. volatile matters.

FIG. 4.—RHENISH-WESTPHALIAN COKE FROM UNCOMPRESSED COAL.

Analysis.—9.5 per cent. ash; 1.276 per cent. sulphur; 1.02 per cent. volatile matters.

If coke is often called improved coal, the sort reproduced in Fig. 3 particularly deserves this name; it is a specimen of the best foundry coke produced in the Rhenish-Westphalian manufacturing district. This coke is somewhat smooth to the touch; it is rather dense without being too firm. The pieces are medium-sized. Even under the magnifying glass not the smallest impurities can

be perceived, and the colour is silvery-grey to the bottom of the pores, which points to a coal faultlessly washed. Thus, this coke has only 6.1 per cent. of ash, 0.926 per cent. of sulphur, and 0.84 per cent. of volatile matters. Compressed coal was used, which can be recognised easily after some practice.

Fig. 4 shows a good blast furnace coke characterised by firmness and large pieces; it also comes from the Rhenish-

FIG. 5.—RHENISH-WESTPHALIAN COKE FROM COMPRESSED COAL; COLD CONDITION OF OVEN.

Analysis.—7.12 per cent. ash; 1.411 per cent. sulphur; 4.66 per cent. volatile matters.

Westphalian manufacturing district. Its pores show at once that uncompressed coal was used; it is very rough to the touch, and though impurities are not to be found in it, even with the aid of a magnifying glass, its darker colour at the bottom of the pores points to a somewhat greater percentage of ash, provided it does not contain too much water. This coke has 9.5 per cent. ash, 1.276 per cent. sulphur, and 1.02 per cent. volatile matters. It shows but few cracks, and even when dropped on an iron plate from a height of 4 ft. 6 in., seldom breaks. This test shows best the firmness of the coke. A middle-sized piece of coke falling on a firm surface from a height of 4 ft. to 5 ft. should not break, but at the most tear. If it breaks into small pieces, this points to too great firmness, offering resistance to the fire and requiring more pressure of air in the blast furnace. If the coke does not break to pieces and its striking can only be heard in a dull way, if at all, the coke (Fig. 5) is not burnt sufficiently, or with too low a temperature of oven. It does not produce heat enough, is pasty in the blast furnace, and causes bad gases. The corners of the ovens at every door mostly yield, in consequence of the cooling, more or less of such coke. If, however, the whole contents of the oven are of this character, the attendant has to ascertain if the oven is not hot enough, or whether the coal supplied was too meagre or decomposed. In Fig. 5 the cold condition of the oven was to be blamed. The coke was drawn after 46 hours' burning, without any gases worth mentioning showing on the surface of the coke cake. The pieces hardly showed pores, were of blue-black colour, and held the quenching water. The analysis gave the following result:—6.4 per cent. water; 7.12 per cent. ash; 1.411 per cent. sulphur; and 4.66 per cent. volatile matters.

(To be continued.)

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THE directors of the Bengal and North-Western Railway Company have placed with the North British Locomotive Company, Limited, of Glasgow, orders for six passenger engines, 33 mixed traffic engines, and for six side-tank engines.

MESSRS. R. WHITE & SONS, railway engineers, of Widnes, have now started work again in their new premises, after the disastrous fire which burnt their works down to the ground in April last. Messrs. White have considerably enlarged their works.

MR. B. NORTON, managing partner of the Norton Harty Engineering Company, Tipton, has severed his connection with the firm, which he established about four years ago. Mr. Norton has now formed a limited liability concern, styled Norton's (Tividale), Limited, which has started business at the Hecla Works, Tipton, as colliery equipment specialists. The original business will be continued by Messrs. P. A. Norton and G. Norton under the existing style of the Norton Harty Engineering Company.

TRADE TALK.

F. E. Baker, Limited, engineers, are removing from Potter Street to Moorsom Street, Birmingham.

Messrs. J. Noble and H. Marks, engineers, Felling-on-Tyne, Durham, have dissolved partnership.

The Tempered Spring Company have transferred their business to the Burton Weir Works, Sheffield.

Messrs. J. Jeffries and A. S. Klumpp, engineers, Kingston-on-Thames, have dissolved partnership.

Workman, Yeames & Company, Limited, engineers, of Belfast, have decided to retire from business.

The statement of affairs of E. J. Raybould & Company, Limited, engineers, Workington, shows a deficiency of £18,000.

Messrs. J. S. Doig, W. Bacon, and J. H. Lodge, trading as Doig & Bacon, engineers, Fleetwood, have dissolved partnership.

A fire broke out on the premises of the Sandholme Iron Company, Todmorden, recently, doing damage estimated at £1,000.

Mr. A. Murray, London representative of the Grangemouth and Greenock Dockyard Company, has removed to 102, Fenchurch Street, London, E.C.

The Blake Boiler, Wagon and Engineering Company, of Darlington, are supplying the South Indian Railway Company with 115 all-steel covered bogie wagons.

Mr. Maurice Graham has resigned his interest in the firm of Messrs. Graham, Morton & Company, engineers, Leeds, to establish himself in business as a consulting engineer in London.

A dissolution of partnership is notified in connection with Messrs. E. B. Caird, T. J. Rayner, and F. Grimble, engineers, etc., Commercial Road, London, E., so far as regards Mr. T. J. Rayner.

Bradley & Craven, Limited, Westgate Common Foundry, Wakefield, are supplying a complete plant for briquetting small iron ore to Messrs. William Baird & Company, Limited, Eglington Iron Works, Kilwinning.

Willans & Robinson, Limited, of Rugby, have acquired the right for the use of the "Contraflo" type of surface condenser, in addition to the "Vacuum Augmenter" system, which owes its introduction to the Hon. C. A. Parsons.

Mr. A. F. Pease, speaking at the annual meeting of the Normanby Iron Works Company, Limited, remarked that the price of pig-iron had gone up about 10s. per ton, but the increase in profits was only about 1s. more, owing to the increased cost of raw material.

Mr. F. H. Preece has established himself in business at 27, Clement's Lane, London, E.C., as agent and engineer for mechanical, steam, and electrical plant. He has been appointed agent for Messrs. Brown & Wade, High Wycombe, and La Société Suisse des Machines Lentz, Bellinzona.

W. H. Bailey & Company, Limited, Albion Works, Salford, Manchester, are supplying one of their "Köster" patent air compressors to the South-Eastern and Chatham Railways, capable of dealing with 60,000 cubic feet of free air per hour, and another to the Daimler Motor Company, Limited, Coventry, to deal with 14,000 cubic feet per hour.

The public examination took place recently in the London Bankruptcy Court of Mr. J. Radcliffe, engineer, 34, Old Broad Street, E.C. The accounts showed liabilities £1,509, and assets valued at sufficient to yield a surplus of £404. The debtor promoted the Radcliffe Engineering Works, Limited, but the flotation was not a success. The examination was concluded.

In connection with the proposed increase in the capital of John Brown & Company, Limited, rendered necessary by the fusion of interests with Harland & Wolff, Limited, the directors have decided to issue to shareholders in proportion to their holding 150,000 £1 ordinary shares at 32s. 6d. per share. It is proposed to issue the new preference shares in the autumn.

The locomotive department of Andrew Barclay, Sons & Company, Limited, Caledonia Works, Kilmarnock, continues to be fully occupied with orders, the latest received being from Messrs. Morrison & Mason, for a narrow gauge locomotive, with cylinders 10 in. diameter by 18 in. stroke, and from the River Wear Commission for a standard 14-in. saddle-tank shunting engine.

Messrs. Yarrow & Company, the well-known Poplar shipbuilders, have now started operations at their new works on the Clyde. The site has a river frontage of 780 ft., extending landwards a distance of about 710 ft. The engineers' shop is 210 ft. in length, and is divided into three

bays, the widest of which is supplied with a 50-ton electric travelling crane on the upper of two sets of rails, and a 5-ton crane on the lower set. The boiler shops are 300 ft. in length, and fitted up with all the latest appliances.

THE Ayrshire Foundry case has again been mentioned in the Commons during the month, when Mr. Lea asked the Secretary to the Admiralty whether he would publish a report giving all the facts and correspondence connected with the alleged fraud committed by the Ayrshire Foundry Company on the Admiralty. Mr. Lambert, who replied, said all the information in the possession of the Admiralty had been placed at the disposal of the Public Accounts Committee by an official cognisant of the facts. The evidence would be published in the usual course.

AT a meeting of the shareholders of the Meadow Foundry Company, Limited, ironfounders and engineers, Mansfield, recently, Mr. J. E. Birks (chairman), on behalf of the shareholders, presented Mr. William Richardson, on his retiring from the position of managing director, with a handsome silver salver suitably inscribed, as a mark of their esteem and appreciation of his services since the formation of the company—a period of 35 years—following on four years with its predecessors. Mr. E. E. Mawle, (late assistant-manager), who has been associated with the firm for some years, has been appointed managing-director.

THE following prices were secured at the recent sale of plant and machinery at the Innox Foundry, Trowbridge, Wiltshire, the property of Messrs. I. Cordingley & Company:—Treble-geared lathe, £42; 10-in. centre sliding and screw-cutting gap lathe, £15 10s.; 9-in. sliding, surfacing, and screw-cutting lathe, £19; pillar drilling machine, £13; bench drilling machine, £4 10s.; heavy planing machine, £31; shaping machine, £13; Root's No. 1A blower, by Thwaites Bros., £6; Day & Milward's weighing machine, £3. A large number of moulding boxes were sold, including 7 pairs 6 by 7½ and 15 pairs 12 by 12, for £3 3s.; 6 pairs 18 by 18, £3 7s. 6d.; 1 pair 6 ft. by 14 in., and 2 pairs of 7ft. by 14 in., £2 12s. 6d.; 2 pairs 2 ft. 3 in. by 2 ft. 3 in., 3 top boxes ditto, and 5 middle boxes ditto, for £2 17s. 6d., etc.

JUDGMENT was given at Halifax County Court, recently, in an action in which Messrs. Mallinson & Sons, ironfounders, Hipperholme, claimed £9 0s. 5d. for work done from Maudsley Brothers, machine tool makers, Boothtown, Halifax. The debt was admitted, but defendants put in a counter-claim against the plaintiffs for £10 6s. 6d., value of patterns which were in the care of the plaintiffs and were destroyed by fire whilst in the plaintiffs' possession. The judge found that the onus of proof lay upon the plaintiffs of showing that they took reasonable care whilst bailees of the patterns entrusted to their care. They had not satisfied him that reasonable care was taken in respect of the fact that they had no night watchman or caretaker on the premises. On that ground he found for the defendants on the counter-claim, and gave a verdict of £1 6s. 1d. due to the defendants and costs on the full amount of the counter-claim.

PARTICULARS have now been published of the Franco-British Exhibition of Science, Arts, and Industries, which will be opened in Shepherd's Bush, London, in 1908. The classification of groups and chairmen of committees, so far as they affect the industries represented by this journal, are as follows:—Engineering and shipping, Sir William H. White (Hon. Vice-President Institute of Naval Architects, Past-President Institute of Civil Engineers, Past-President Institute of Mechanical Engineers); constructional engineering, Sir Alexander Binnie (Past-President of the Institute of Civil Engineers); mechanical engineering, Mr. T. Hurry Riches (President of the Institute of Mechanical Engineers); gas engineering, Mr. Henry E. Jones (Past-President of the Institution of Gas Engineers); electrical engineering, Dr. R. T. Glazebrook (President of the Institute of Electrical Engineers); metallurgical engineering, Sir Charles McLaren, Bart., M.P.; iron and steel, Sir Hugh Bell, Bart., J.P., D.L. (President of the Iron and Steel Institute); shipbuilding and marine engineering, Dr. Francis Elgar (Vice-President and Treasurer of Institution of Naval Architects).

—o—

NEW COMPANIES.

WHITEHEAD (ENGINEERS), LIMITED.—Capital £2,000. Registered office: Victoria Street, Sandholme, Todmorden.

PENMAN & COMPANY, LIMITED.—Capital £70,000, to acquire the engineering business of Penman & Company, Glasgow.

HUGGETT & WORTHINGTON, LIMITED.—Capital £500, to acquire the engineering business carried on at 85, Bridge Street, Warrington, as Huggett & Worthington.

J. Crawford & Sons, Limited.—Capital £2,500, to acquire the Bonner's Field Engine Works, Monkwearmouth, Sunderland.

Marten & Jellicoe, Limited.—Capital £10,500, to carry on the business of engineers. Registered office: 75-77, Shaftesbury Avenue, W.C.

Ashworth, Son & Company, Limited.—Capital £5,000, to acquire the business of Ashworth, Son & Company, Midland Iron Works, Dewsbury.

Harvey, Son & Company, Limited.—Capital £200, to carry on in Birmingham the business of iron, brass, and general founders, etc.

Chisholm Manufacturing Company, Limited.—Capital £10,000, to acquire the business at Birmingham of the Chisholm Manufacturing Company.

Thomas Evans & Son (Poplar), Limited.—Capital £7,000, to acquire the engineering business of Thomas Evans & Son, 32, North Street, Poplar.

Atlantic Works (late Mary Wearing & Sons), Limited.—Capital £1,000, to acquire the founders' business formerly carried on as Mary Wearing & Son.

I. & B. Umpleby, Limited,—Capital £6,000, to take over the business of steam boiler makers, etc., carried on by I. & B. Umpleby, at Perseverance Works, Moorbottom, Cleckheaton.

MacTaggart, Scott & Company, Limited.—Capital £10,000, to take over the business of MacTaggart, Scott & Company, Station Iron Works, Loanhead.

George Young, Limited. — Capital £10,000, to acquire the business of an engineer, ironfounder, etc., carried on at Middle Abbey Street, Dublin, by Geo. Young.

Brandford Brothers, Limited. — Capital £5,000, to take over the business of aluminium, brass and ironfounders, etc., carried on at Bilston as Branford Brothers.

W. Brittain & Company, Limited.—Capital £2000, to acquire the engineering business of Wm. Brittain & Company. Registered office: 80, Liverpool Road, Stoke-on-Trent.

G. P. Wilson & Son, Limited.—Capital £2,000, to take over the business of Wilson & Son. Registered office: Bridge Foundry, The Foreshore, Northam, Southampton.

PERSONAL.

Mr. R. A. Hadfield, of Sheffield, has returned to this country from New York.

Mr. W. Armstead has been elected to the board of Thomas Parker, Limited, Wolverhampton.

Mr. W. Ellis, of Workington, has been elected a director of the Workington Iron Company, Limited.

The late Mr. C. H. Oakes, of Messrs. James Oakes & Company, left estate valued at £154,762 gross.

The late Mr. A. Brown, of William Simons & Company, Limited, left estate (personal) valued at £107,024.

Mr. R. G. Chambers, a director of the North Central Wagon Company, Limited, Rotherham, has resigned.

Mr. A. E. Lamb, manager of the Whitehaven Hematite Iron Company, has been made a J.P. for Cumberland.

Sir Christopher Furness, M.P., has presented a framed photograph of himself to the Hartlepool Corporation.

Mr. H. H. Bedford, chairman of John Bedford & Sons, Limited, Lion Works, Sheffield, has been elected Master Cutler.

The late Sir Alexander Wilson, managing director of Cammell, Laird & Company, Limited, left estate valued at £213,397 gross.

Mr. J. Apsey, chief constructor at Malta Dockyard, has been appointed manager of the constructive department of Portsmouth Dockyard.

The Hon. Ronald Dudley Kitson has been elected a director of Bolckow, Vaughan & Company, Limited, in place of Mr. E. Windsor Richards, resigned.

Mr. H. P. Hussey, secretary of the Thames Iron Works, Shipbuilding, and Engineering Company, Limited, has resigned, and will be succeeded by Mr. J. Worsfold.

Mr. T. Mitchell, the manager of the Constructive Department of the Royal Dockyard, Portsmouth, who willl shortly retire, has had the honour of knighthood conferred upon him.

Mr. P. F. Nicholson, manager of the Hebburn shipyard of Messrs. R. & W. Hawthorn, Leslie & Company, has been appointed to a position at the Quarry Bay shipyard, Hong Kong.

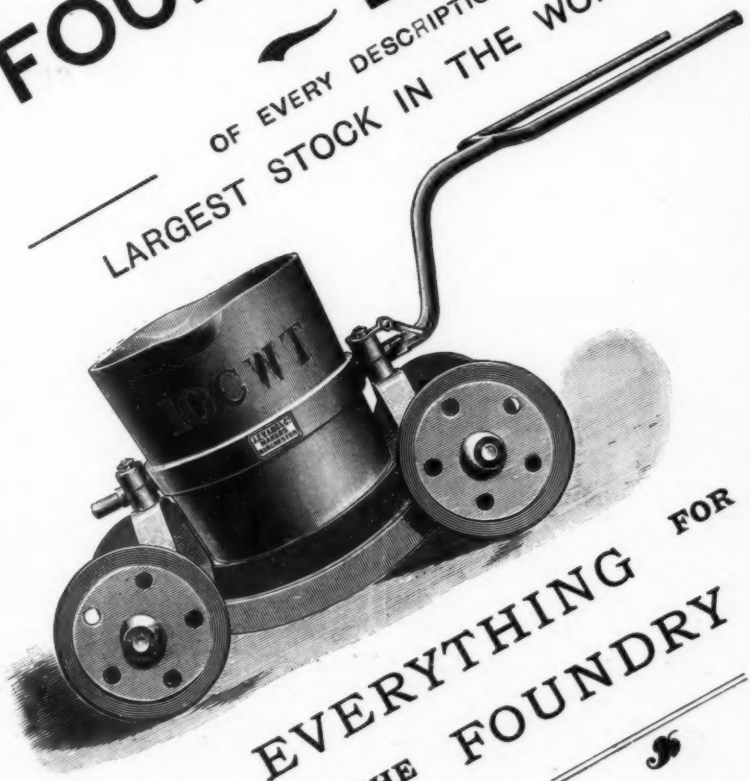
The gross value of the estate of the late Mr. W. Dobson, of Messrs. Wm. Dobson & Company, and the Wallsend Slipway and Engineering Company, Limited, is £124,433.

Contractors to H.M. Government.

FOUNDRY LADLES

OF EVERY DESCRIPTION.

LARGEST STOCK IN THE WORLD.



EVERYTHING FOR THE FOUNDRY

JAMES EVANS & CO.,

Telegrams:
"LADLES, MANCHESTER."
"BLACKINGS, GLASGOW."

BRITANNIA WORKS, MANCHESTER.

DEATHS.

MR. J. SHAW, of Messrs. Shaw & Gaskell, boilermakers, Hull.

MR G. F. PEARSON, a director of the Pearson and Knowles Coal and Iron Company, Limited.

MR. R. SELLERS, a member of the firm of Darling & Sellers, Limited, machine tool makers, Keighley.

MR. A. GRAFTON, head of the firm of Grafton & Company, of the Vulcan Iron Works, Elstow Road, Bedford.

MR. A. HILLS, of Osgathorpe Road, Sheffield, who for many years was a director of William Jessop & Sons, Brightside, in his sixty-fifth year.

SIR JOHN D. MILBURN, BART., at his residence at Guyzance, Acklington, in his fifty-seventh year. The deceased baronet was chairman of the Hebburn Boiler Company, Limited, and in 1892, when Palmer's Shipbuilding and Iron Company was in some distress, he was induced to join the board of directors, remaining chairman until the concern returned to a prosperous career in 1897.

Ganister, Cupola Blocks, Fire Bricks,
Fire Clay.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
Steel Moulders' Composition, Silica Cement.

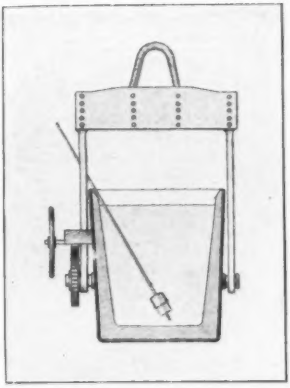
J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

SIMPLEX FOUNDRY SPECIALITIES

HAND AND POWER MOULDING MACHINES.
MULTIPLE MOULDING MACHINES.
Crucible Furnaces, Crushing Mills, Pig Breakers.
SAND MIXERS & SIFTERS, &c., &c.

The SIMPLEX COKE OVEN & ENGINEERING CO. LTD.
Head Office: TEMPLE BAR HOUSE, LONDON, E.C.
Glasgow Office: 144, ST. VINCENT STREET.
Telegrams: "Aleof, London." Telephone: 5097, Holborn.

PREVENTION OF BLOWHOLES IN CAST IRON.



A tin of our special compound fixed on a rod is held at bottom of ladle as shown; a strong re-action being thereby set up frees the iron from gases and impurities, which rise to the top.

RESULT: A denser casting of finer grain with increased strength.

For Particulars apply to—

THERMIT LIMITED,

27, MARTIN'S LANE, CANNON STREET,

Telephone—3749 Central.
Telegrams—"Fulmen," London.

LONDON, E.C.

ELDERS FOUNDRY COKE

As supplied to the British . . Admiralty Dockyards.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.

We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blow-holes and other defects, than we formerly did.

From MOUNTFORT PHILLIPS & Co., Llantrissant.

Llantrissant, October 25th, 1904.

In reference to the Foundry Coke you have been supplying us with for the last six months, we have very great pleasure in letting you know that it has given every satisfaction, and that our Works Manager and Workmen give it the highest praise.

Elders Navigation Collieries, LTD. Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

Metals.	1906-7.	1905-6.
Iron—Scotch pig warrants ... ton	*65 0	59 0
—Middlesbro' warrants ... ... ton	56 9	54 0
—W.C. M/nos Bessemer ... ... ton	80 6	68 0
—Stock, Scotch, August 29 ... tons	1,860	11,284
Copper—Chili bars, GMB ... ... ton	£79 7/6	£84 17/6
—Stock, Europe & afloat... ... tons	14,232	12,355
Tin—English ingots ton	£172 10/0	—
—Straits ... ton	£169 15/0	£182 10 0
—Stock, Ldn. Hind and aflt ... tons	—	12,295
Lead—English pig ton	£20 0/0	£17 15/0
Spelter—Ord. Silesian ... ... ton	£21 15/0	£27 5/0
Quicksilver—(75lb.) bottle	£6 16/0–£7	£7 0/0
Antimony—Regulus ... ... ton	£35–£40	£104 0/0

*Settlement price.

Castings.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	7 0 0	to	7 5 0
Pipes, 1½ to 2½ in.	5 10 0	to	5 15 0
,, 3 to 4 in....	5 2 6	to	5 10 0
,, 5 to 8 in.	5 0 0	to	5 2 6
,, 10 to 16 in....	5 0 0	to	5 2 6
,, 18 to 24 in....	5 0 0	to	5 2 6
Chairs	4 2 6	to	4 5 0
Floor plates (open sand)	3 7 6	to	3 15 0

Scrap.

The quotations for scrap, subject to market fluctuations, are as follows: — Heavy wrought (mixed), £2 17s. 6d.; light wrought, £1 12s. 6d.; heavy cast, £2 11s. 6d.; all per ton f.o.b., London. Copper (clean), £71; brass (clean), £49 10s. 0d; lead (usual draft), £18; tea lead, £16 5s. 0d.; zinc, £17 10s. 0d.; all per ton delivered merchant's yard.

SILICA FIRE BRICK Co.,

OUGHTIBRIDGE.

GROUND GANISTER,

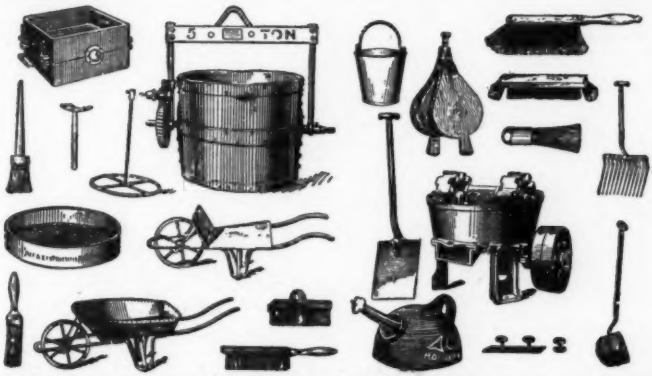
Wet or Dry.

Silco Cupola Bricks, 90 % Silica.

Better than Fire-clay Bricks for Cupolas.

Established 1863.

Jas. Durrans & Sons,



PHŒNIX WORKS, PENISTONE, Near Sheffield.

Manufacturers of all

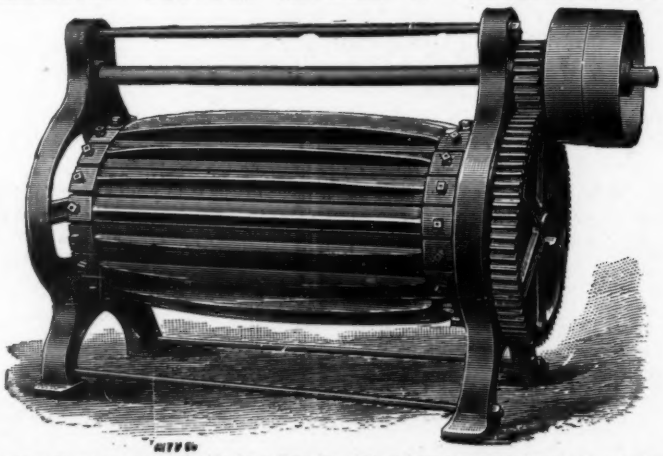
FOUNDRY EQUIPMENTS,

Composition Black Lead,

Plumbago, Core Gum, White Dust, and Coal Dust.

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, &c.

IMPROVED FOUNDRY RATTLER or FETTLING DRUM.

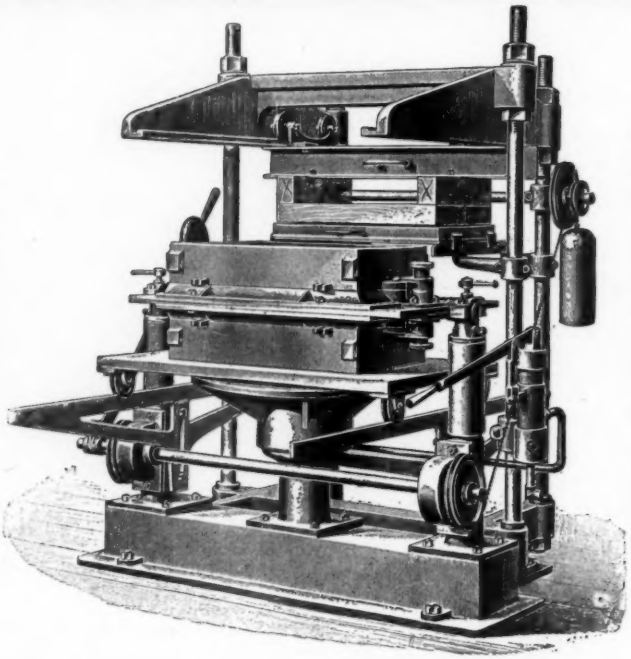


These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

"Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD."

"ATLAS" METALLIC CEMENT.



"ATLAS" METALLIC CEMENT.

HYDRAULIC MOULDING MACHINE

Pattern "L."

This machine is fitted with a revolving pattern plate carrying one half of the Pattern on each side. It is constructed in all sizes from 19 in. by 10 in. to 87 in. by 87 in., and can be arranged with a draw up to 20 in. Bottom and top boxes are made alternately. Any shape or size of box can be used on the machine within the maximum capacity, and in the majority of cases existing pattern plates can be utilised. The pattern is drawn upwards out of the sand without enlarging or breaking the mould. The machine is unsurpassed for deep work and we shall be pleased to show it to you in operation here.

THE CHEAPEST AND BEST POWER TURN-OVER MOULDING MACHINE ON THE MARKET.

Complete Hydraulic Plants, including one of the above Moulding Machines, 16 in. by 12 in. for £115.

A SAND BLAST WILL IMPROVE THE APPEARANCE OF YOUR CASTINGS AND SAVE MONEY.

OUR CONTINUOUS SAND BLAST embodies ALL THE LATEST IMPROVEMENTS and is arranged for ROTARY TABLES, CLEANING DRUMS, TRANSPORTABLE TABLES, CLEANING ROOMS, etc.

THE LONDON EMERY WORKS Co.,

Park, Tottenham, LONDON, N.

SITUATIONS VACANT.

PATTERN MAKER Wanted.—A First-class, thoroughly experienced man for Malleable Iron Work.—Apply, giving details of past experience, etc., to BAGSHAWE & CO., LTD., Dunstable Works, Dunstable.

FOREMAN ENGINEER (general) Wanted, over fitters and turners; splendid position for good man; none but experienced men need apply.—Address, with copies of references, stating age, wages expected, Box 515, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOREMAN MOULDER Wanted for Malleable Iron Work. First-class, reliable, sober man, with experience of annealing.—Apply, giving full particulars of past experience, BAGSHAWE & CO., LTD., Dunstable Works, Dunstable.

FOREMAN MOULDER, smart, young, Wanted, for general and builders' work; only good workmen with plenty of energy need apply. Give full particulars.—Address Box 517, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOR SALE AND WANTED.

FOUNDRY HOIST.—One-ton, belt driven; machinery housed in capital working order; can be seen by appointment; lift about 12 ft. Price £50.—Apply SALMON LANE WHARF, Stepney, London, E.

BRASS FOUNDRY.—Very good Business; splendid for amalgamation with another business. Price £1,100.—Address Box 575, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOR SALE, PATENT RRESSURE BLOWERS FOR CUPOLAS:—

No. 1a size "Allday's" 6 in. outlet, as new.
" 5a " "Thwaite's" 4 in. "
" 2 " " 8 in. "
" 13 " "Baker's" 11½ in. "

One Cupola, 21 ft. 6 in. by 4 ft. diamater, with air belt.

One Boiler Flue for Cupola, 28 ft. by 41 in. diameter.

One Chimney, 26 ft. 36 in. to 24 diameter, ⅜ in. plates.

Address: J. LIGHT, Hope Cottage, Dunstall Road, Wolverhampton.

FOUNDRY EQUIPMENT.

PATENT CORE MAKING MACHINES

No linseed oil or flour required.

NEW PORTABLE MOULD DRIERS

Moulds dried on the spot in an hour to one hour and a half.

J. W. & C. J. **PHILLIPS,**

23, COLLEGE HILL, London, E.C.,

And 7, PARK SQUARE, LEEDS.

FIRE BRICKS & CLAY

CUPOLA BRICKS.

BEST QUALITY.

Lessees of Delph and Tintern Abbey Black and White Clay.

KING BROTHERS,

STOURBRIDGE.

CUPOLA LININGS of "Black Delph" Firebricks

combine great refractoriness with high resistance to abrasion.

E. J. & J. PEARSON, Ltd., STOURBRIDGE.

The most successful Foundry Specialities are

THE PIFTIN SPECIALITIES.

The Piftin Specialities are in universal favour with Founders both large and small, and are in constant use throughout the World.

The reason of their great and continued success is that each Speciality handled by us is proved to be a practical success ***before*** it is placed on the market.

It costs us a lot of money, time, and trouble to ensure this, but then it enables us to fully satisfy our buyers, and we thereby gain what we aim at—The repeat orders of our numerous clientele, both at Home and Abroad.

If, therefore, you are wanting anything for your Foundry, you should get the best of its kind, which is the ***PIFTIN.***

The Piftin High Pressure Blower

Over 80 have been supplied to H M. Government.

The Piftin Portable Mould Drier

In use throughout the World, including the principal British and Continental Foundries.

The Piftin Sand Renovating System

Saves 80% of the yearly sand Bill.

The Piftin Sand Mixing Machine

The most efficient machine on market.

The Piftin Sand Blast Machinery

Adapted for all purposes.

Up-to-date in every respect. The most efficient, most simple, and most easily worked of any apparatus on the market. Saves the entire cost in the first few months.

For further particulars apply to

PIFTIN LIMITED,

143, 145 & 147, ROSEBERY AVENUE,

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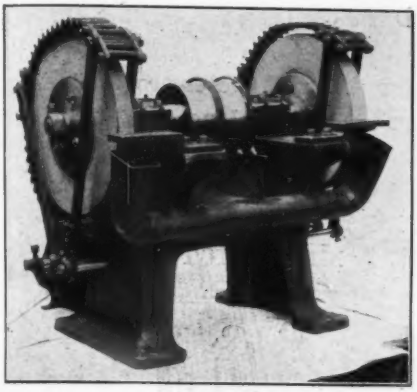
PLEASE NOTE NEW ADDRESS.

Telephone No. 47 Heaton Moor.

MANUFACTURERS OF

Telegraphic Address: "Heroic, Reddish."

Crystal Canadian Corundum,



CARBO CORUNDUM

AND

EMERY WHEELS,

For Foundry Use

ALSO

ALL CLASSES OF

GRINDING . .

MACHINES. . .

Send for Catalogue and Prices.

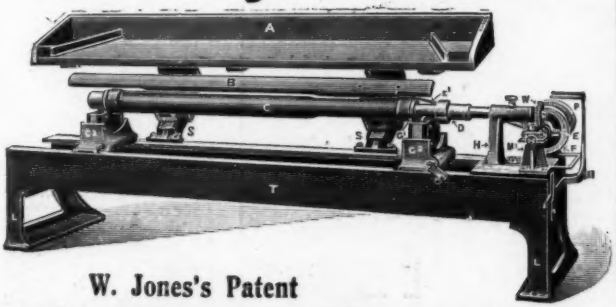
B. R. ROWLAND & CO., LTD.,

REDDISH, Near STOCKPORT.

A REVOLUTION IN

Pipe Foundry Practice

For Pipe Cores, 18 ft. long and 2 in. to 20 in. diameter.



W. Jones's Patent

CORE FORMING MACHINE

JONES & ATTWOOD,

STOURBRIDGE, ENGLAND.

PNEUMATIC PLANT

OF ALL KINDS AND FOR ALL PURPOSES.

Air Compressors, Vacuum Pumps, Receivers, Chipping, Riveting & Caulking Hammers, Drilling Machines, Grinders, Forges, Hoists, Spraying Machines, Painting Machines, Sand Blasting Machines, Sand Shifters, Air Lift Water Pumps, Hose, Fittings, etc.,

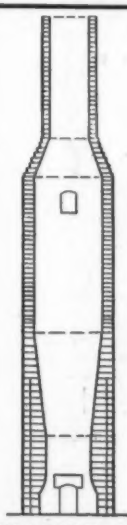
OF BEST BRITISH MANUFACTURE.

LACY-HULBERT & CO., Ld.,

. . . **Pneumatic Engineers,** . . .

91, VICTORIA STREET, LONDON, S.W., and

BOREAS WORKS, BEDDINGTON, Surrey.



Special . .

Quality . .

FIREBRICKS

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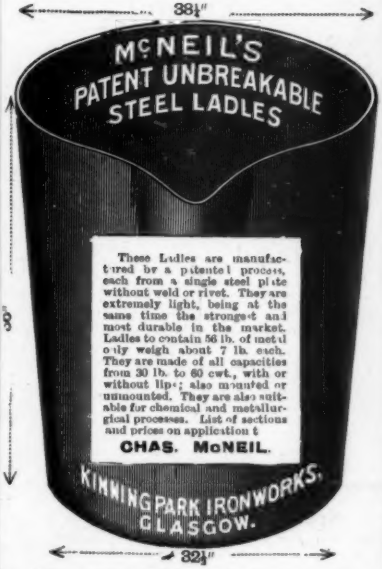
CUPOLA

LININGS.

GEORGE K. HARRISON, Ltd.

Fireclay Brick Works,

STOURBRIDGE.


38¼"
McNEIL'S
PATENT UNBREAKABLE
STEEL LADLES
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips; also mounted or unmounted. They are also suitable for chemical and metallurgical processes. List of sections and prices on application to
CHAS. McNEIL.
KINNING PARK IRONWORKS,
GLASGOW.
30"
32½"

Can also be made in Aluminium.

Telegrams—
"Tuyere, Manchester.

ON ADMIRALTY LIST.

National Telephone—
No. 70, Openshaw.

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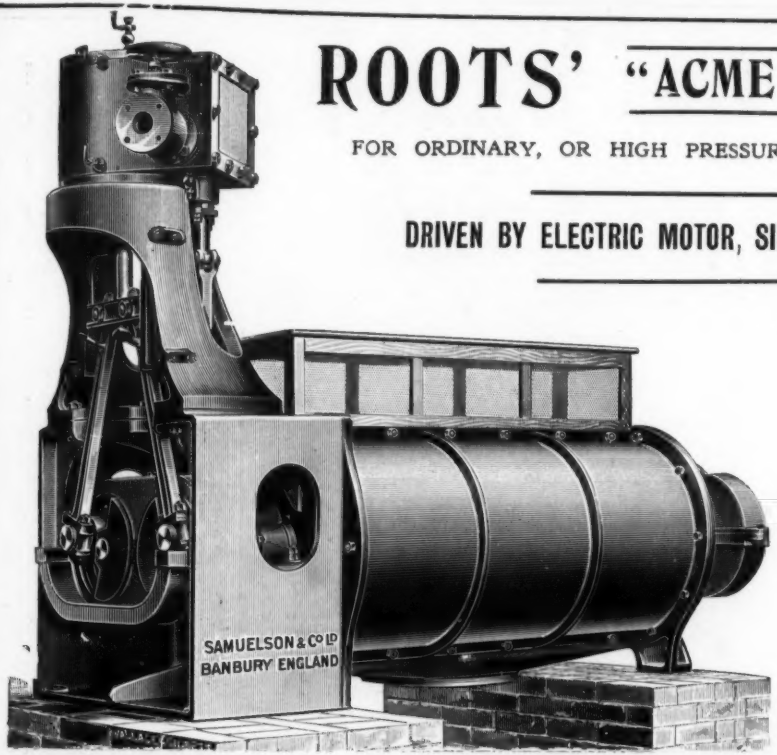

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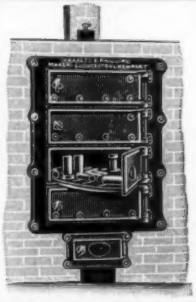

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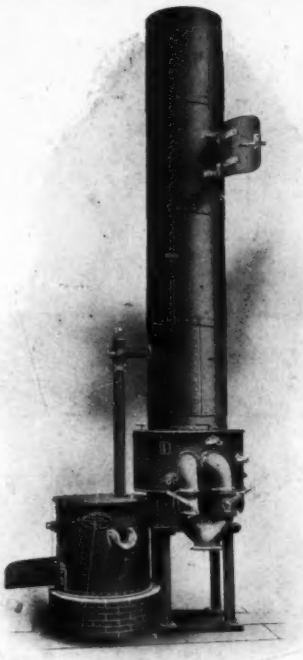

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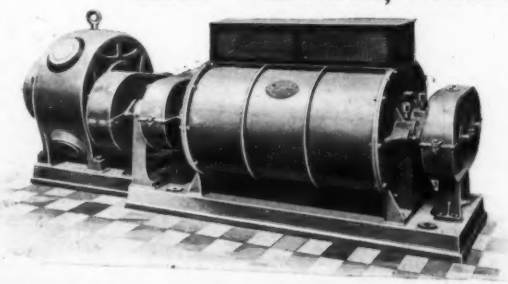

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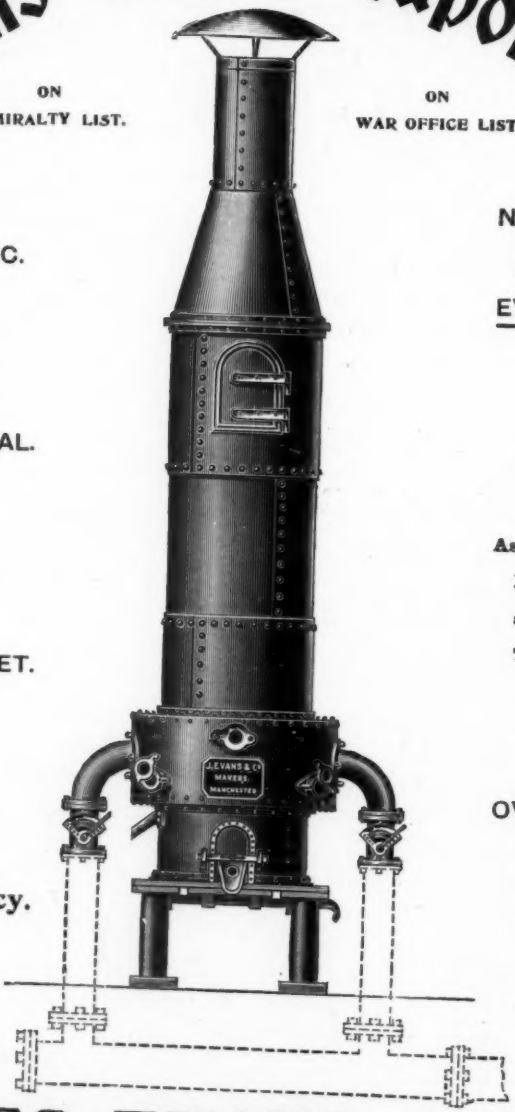

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